Three Momentum Strategies:
Dual Momentum, FundX and SectorSurfer®

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This is a working document. It likely contains errors and misinterpretations.

Introduction

This report compares the historical performance of the Dual Momentum, FundX and SectorSurfer® momentum strategies. These strategies seek to invest in the stocks which are growing in value most rapidly. For a lighthearted introduction to momentum investing, I suggest "Why Newton was wrong[1]." For more information, I suggest Antonacci's book[2] and other references[3].

Let me begin with an analogy. Imagine that you are designing a self driving automobile and you want the car to perform safely on streets with a maximum speed of 45 mph and on freeways with a maximum speed of 65 mph. One approach would be to set the maximum speed at 45 mph in both environments. A second approach would be to use an algorithm to determine whether the car is on a street or on a freeway and to set the maximum speed accordingly.

The first option is akin to including sufficient bonds in the portfolio so that the portfolio safely navigates market downturns. The second option is akin to using an algorithm to determine whether the portfolio should be bond-heavy because the market is in turmoil or whether it is smooth driving and bonds are not needed.

The second option is typically part of a momentum strategy. The "timing" algorithm decides whether it is better to own stocks or bonds in the current market environment.

Momentum strategies also typically involve an allocation decision. Which stocks or stock funds are likely to outperform?

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[1] *The Economist,* January 8, 2011, www.economist.com/node/17848665.

[2] Gary Antonacci, *Dual Momentum Investing*, McGraw Hill, 2015.

"Annotated Bibliography of Selected Momentum Research Papers," www.aqrindex.com.

[3] "Fact, Fiction and Momentum Investing" by Clifford S. Asness, Andrea Frazzini, Ronem Israel and Tobias J. Moskowitz, papers.ssrn.com/sol3/papers.cfm?abstract_id=2435323.

"Relative Strength and Portfolio Management" by John Lewis, Dorsey Wright & Associates, 2012. Available at papers.ssrn.com/sol3/papers.cfm?abstract_id=1998935.

Dual Momentum addresses the timing and allocation decisions by comparing returns over the trailing 12-months[4].

- Absolute Momentum decides between stocks and bonds based on whether the 12-month total return[5] of the S&P 500 Composite exceeds the 12-month total return of T-bills.
- Relative Momentum decides between US and foreign stock funds based on relative 12-month total returns.

The *NoLoad FundX Newsletter* has been published since 1976[6]. The newsletter ranks funds for inclusion in the portfolio based on the several factors including the average of the fund's 1-, 3-, 6- and 12-month total returns. The NoLoad FundX strategy does not make an explicit decision between stocks and bonds.

The FundX *timing* algorithm used here applies the 1-, 3-, 6- and 12-month algorithm to the S&P 500 Composite[7]. When the average return of the Composite is positive, the recommendation is to own stocks. When the average return is negative, the recommendation is to own bonds.

SectorSurfer® offers three timing algorithms. The original timing algorithm, StormGuard® standard, is the double exponential moving average (DEMA) of the daily returns of the S&P 500 Composite *without dividends* plus a shift.

SectorSurfer® allocates to the fund with the highest trend. SectorSurfer® measures the trend of a fund as the double exponential moving average of the daily returns of that fund.

The value of a DEMA algorithm depends on a parameter which Scott Juds, the creator of SectorSurfer®, calls the "trend constant." StormGuard® standard uses a trend constant of 50 days[8]. The DEMA algorithms used to calculate the trends determine the trend constant through an optimization process.

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[4] Antonacci, *op. cit*., describes his Dual Momentum strategy on p. 98. Antonacci describes variations of his strategy but he does not use the variations in the preparation of his charts and tables.

[5] Unless otherwise stated, all returns and prices assume the reinvestment of dividends.

[6] FundX Investment Group, www.fundx.com.

[7] Table C-3 in Appendix C illustrates the performance of this indicator with various risk indices.

[8] The original definition of StormGuard® standard was 22 * DEMA50 + 0.006. The 22 factor adjusts the daily DEMA to a monthly DEMA assuming 22 market days per month.

The definition has been revised to 21 * DEMA50 plus 0.0055.

SectorSurfer® does not report the value of the shift to sufficient precision to allow a determination of whether the code was actually changed to reflect the new definition.

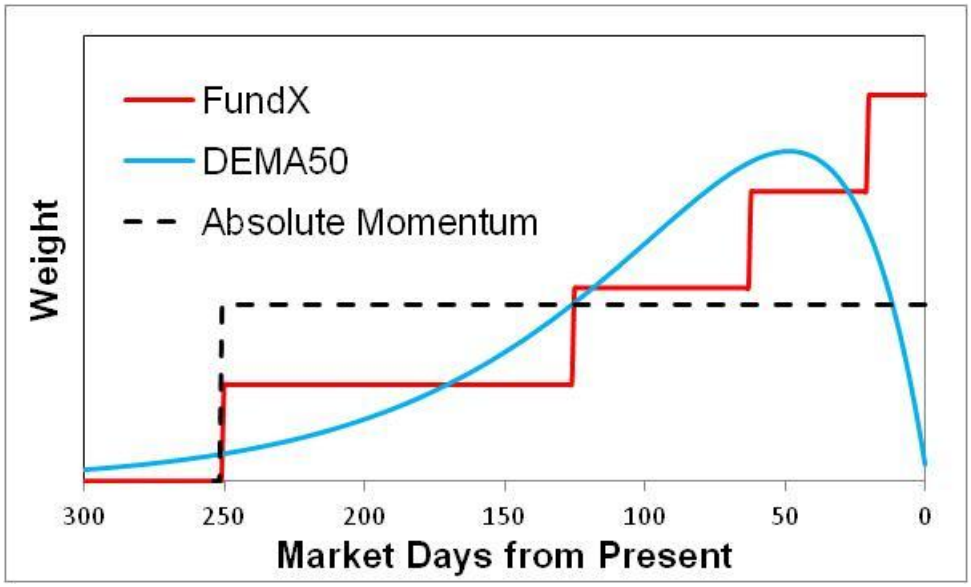
For equivalence between the original and revised definitions, the revised shift should be 21*0.0060/22 = 0.00573 rather than 0.00550. The difference is not considered material.

The value of the shift is portfolio dependent, ranging from a low of about 0.003 to a high of about 0.008. The value of the shift for the SIMPLE portfolio is 0.006. In this report, we define StormGuard® standard as 22 * DEMA50 plus 0.006 for all portfolios.

DEMA algorithms are discussed in Appendix A.

The Absolute Momentum, FundX and StormGuard® timing algorithms are based on the price changes of the S&P 500 Composite but the algorithms emphasize different time regions.

Chart 1. Timing Algorithms Emphasize Different Portions of the Data History.
Source: theory.xls.



Comment. "Source: theory.xls" and similar references in the charts and tables cite internal documents. References to external sources appear in the footnotes.

Absolute Momentum does not distinguish among price changes over the past twelve months. Absolute Momentum algorithm puts the same emphasis on price changes last month and eleven months ago. This is illustrated by the dashed line in the chart. Absolute Momentum places more emphasis than the other algorithms on price changes more than six months ago and less emphasis on price changes during the most recent six months.

The FundX timing algorithm places more emphasis on recent price changes than do the other algorithms. The FundX timing algorithm is expected to be more responsive to recent market performance than the other algorithms.

StormGuard® standard places the least emphasis on what happened over the past month and the greatest emphasis on what happened from one to six months ago. Price changes more than 300 days ago have a measurable effect on the value of the StormGuard® timing algorithm.

Price Data

The price data used in this report are from the following sources[9].

Bonds	Spliced VBMFX: Intermediate Term Government Bonds (SBBI) before September 1988 and the mutual fund VBMFX thereafter. The VBMFX benchmark is the Barclays US Aggregate Bond Index.
T-bills	Spliced BIL: 13-week T-bills (^IRX) to June 2007 and BIL thereafter. BIL is an exchange traded fund which uses the Barclays 1-3 Month U.S. Treasury Bill Index as its benchmark.
US Stocks	Spliced VFINX: S&P 500 Composite (SBBI) before September 1988 and the mutual fund VFINX thereafter. VFINX uses the S&P Composite with dividends as its benchmark.
Foreign Stocks	Spliced HAINX: MSCI-EAFE (net of foreign tax) before September 1988 and the mutual fund HAINX thereafter. HAINX is an actively managed fund. The mutual fund VGTSX is more representative of foreign stocks because it uses the FTSE World exUS Index as its benchmark. Unfortunately, VGTSX has no data history before May 1996.
Real Estate	Spliced FRESX: FTSE NAREIT US Real Estate "ALL REITS" Index before September 1988 and the mutual fund FRESX thereafter. FRESX is an actively managed fund which uses the MSCI US REIT Index as its benchmark.

[9] SBBI refers to Ibbotson's "Stocks, Bonds, Bills and Inflation Yearbook" published by Morningstar, Inc. SBBI attributes the large company stock total returns from 1977 - August 1997 to the American National Bank and Trust Company of Chicago and to Standard and Poor's thereafter.
Daily data for the S&P 500 Composite without dividends are from Yahoo.com (^GSPX) and FastTrack.net (SP-CP).
Monthly data for the MSCI-EAFE index are from msci.com. This index excludes the US, Canada and emerging markets.

Monthly data for the FTSE NAREIT All REITs Index are from reit.com. This is a market capitalization-weighted index that includes all tax-qualified real estate investment trusts (REITs) that are listed on the New York Stock Exchange, the American Stock Exchange or the NASDAQ National Market List.

Market day returns of 13-week T-bills: (1+^IRX/100)^(1/252). Daily ^IRX data are from Yahoo.com.

Daily data for stocks, mutual funds, ETFs and indices after August 1988 are from FastTrack.net.

Monthly data for the equal weighted Wilshire 5000 index are from wilshire.com.

Monthly returns for the AAII Shadow Stock portfolio were supplied by Wayne Thorpe in January 2017.

Determining the Timing and Allocation Signals

The signals for the simpler momentum algorithms can be calculated using dividend adjusted prices from a free source like Yahoo.com.

If you are seriously into momentum strategies, it is worth the effort to code the calculations in a spreadsheet and it is worth considering the purchase of a data license. There are often problems in the automated transmission of fund dividends. Investors FastTrack, my data provider, corrected more than fifteen hundred dividends in the first week of January 2017. Free sources may correct fewer errors

The data used here were downloaded from Yahoo.com on January 15, 2017. I mention the date because the dividend adjusted prices could be different if downloaded today because the adjusted prices change every time a dividend is posted.

The changes are of no import because returns are determined from price ratios and price ratios do not change if the dividend adjustments are made properly.

The Absolute Momentum timing signal at the end of August, 2015 compares the 12-month return of US stocks to the 12-month return of T-bills. The investor's first decision is to decide which funds to use as surrogates for "US stocks" and for "T-bills." I'm using the Vanguard Index 500 fund (VFINX) as the surrogate for US stocks and BIL, an exchange traded fund which tracks the Barclays 1-3 Month U.S. Treasury Bill Index, as the surrogate for T-bills.

You may prefer a broader stock fund or a different T-bill index.

The 12-month return is the ratio of the dividend adjusted price today divided by the dividend adjusted price 12 months ago, minus 1. The "minus 1" can be neglected since it is common to both ratios.

	VFINX	VTSMX	BIL
August 29, 2014	176.45	48.25	45.73
August 31, 2015	177.07	48.33	45.68
Ratio	1.004	1.002	0.999

Because the 12-month ratio for US stocks is larger than the ratio for T-bills, the Absolute Momentum signal is to own stocks during September 2015.

It does not matter in this instance whether US stocks are represented by VFINX or by VTSMX which is a broader index representing the total US market.

The FundX timing signal requires five dividend adjusted prices. The signal is to buy stocks if the average of the 1-, 3-, 6- and 12-month returns is positive.

We do not need to calculate the average of the returns. It is sufficient to calculate the sum of the 1-, 3-, 6- and 12-month price ratios minus 4.

	VFINX	VTSMX
August 29, 2014	176.45	48.25
February 27, 2015	187.12	51.08
May 29, 2015	188.26	51.47
July 31, 2015	188.46	51.41
August 31, 2015	177.07	48.33
Sum of Price Ratios - 4	-0.170	-0.173

The sum, and hence the average, is negative. The FundX signal is to hold bonds during September 2015.

The choice of US stock surrogate, VFINX or VTSMX, makes no difference in this instance.

While the calculation of the StormGuard® standard timing signal is not difficult[10], the calculation does require about three or four hundred daily returns and a spreadsheet.

Fortunately, there is no need to calculate this signal. Juds provides the signal for free, every day, at www.sumgrowth.com/InfoPages/Market-Sentiment.aspx.

The value of the signal at the end of August 2015 is positive and the recommendation is to own stocks during the following month.

The Relative Momentum allocation algorithm compares the trailing 12-month returns of US and foreign stocks using the Harbor International fund (HAINX) to represent the performance of foreign stocks. You may prefer to use another mutual fund or ETF as your surrogate for foreign stocks and two possibilities are shown in the following table.

	VFINX	HAINX	VGTSX	VEU
August 29, 2014	176.45	65.82	16.18	48.48
August 31, 2015	177.07	59.87	14.27	42.77
Price Ratio	1.004	0.910	0.882	0.882

Since the price ratio for US stocks is larger than the price ratio for foreign stocks, the Relative Momentum allocation algorithm recommends holding US stocks during September 2015.

[10] The DEMA calculation is illustrated at www.lingane.com/sectorsurfer/discussion.pdf.

The other foreign stock surrogates lead to the same allocation decision in this instance.

The FundX allocation algorithm[11] compares the average of the 1-, 3-, 6- and 12-month returns of US stocks to the average of the 1-, 3-, 6- and 12-month returns of foreign stocks. We have already calculated the average for US stocks.. All we need do now is repeat the calculation for foreign stocks.

	VFINX	HAINX	VGTSX	VEU
August 29, 2014		65.82	16.18	48.48
February 27, 2015		64.66	15.56	46.81
May 29, 2015		67.25	15.94	47.84
July 31, 2015		65.09	15.39	46.36
August 31, 2015		59.87	14.27	42.77
Sum of Price Ratios - 4	-0.170	-0.354	-0.378	-0.388

Since the sum of the ratios– 4 for US stocks is less negative than the average for foreign stocks, the average for US stocks will be less negative than the average for foreign stocks. The FundX allocation algorithm recommends holding US stocks during September 2015.

The other foreign stock surrogates lead to the same allocation decision in this instance.

SectorSurfer® measures the trend of each fund as the double exponential moving average of that fund's daily returns. This means a spreadsheet with hundreds of daily prices for each fund in the portfolio.

The bigger challenge is that SectorSurfer® determines the trend constant for the DEMA calculation through an optimization process. Investors may find the optimization process difficult to replicate.

The easiest way to acquire the DEMA trends for portfolios with twelve or fewer fund is to purchase a SectorSurfer® license.

Alternatively, an investor could develop software or the portfolio could be managed using Relative Momentum and Absolute Momentum alone.

[11] Jay Matsuda of the FundX Investment Group e-mailed me on September 26, 2016 that the FundX score is the average the average monthly returns over 1-, 3-, 6- and 12-months. If a fund were appreciating at a uniform 1% a month, the average of the average monthly returns would be

(1% + 1% + 1% + 1%) / 4 = 1% per month plus any bonus points.

If there were 4 bonus points because the fund was among the top 15 funds in each of the four intervals, the FundX score would be 1 + 4 = 5.

As implemented here, the FundX indicator would be the average of 1.01^12 + 1.01^6 + 1.01^3 + 1.01 – 4 which equals 0.229/4 or 0.057. There are no bonus points.

We will show that neglecting the SectorSurfer® allocation algorithm makes little difference for the SIMPLE portfolio but that DEMA allocation algorithms are beneficial for more complex portfolios.

Timing and allocation signals tend to change slowly over time. This means that it is usually possible to make allocation decisions during the last weekend of the month with trades executed on the month-end date.

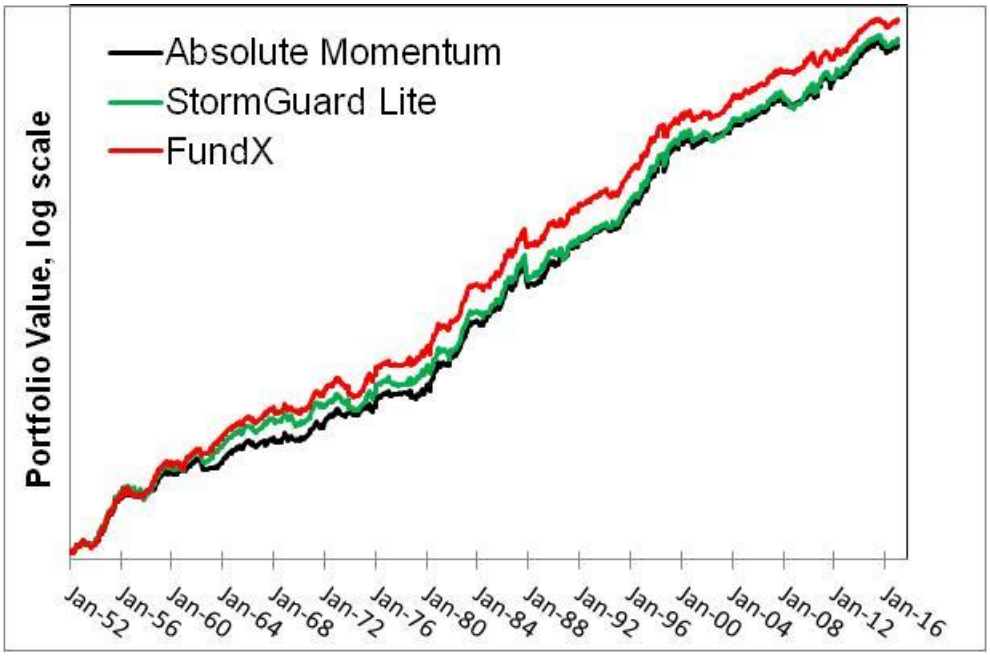
Performance of the Timing Algorithms

I prefer to test algorithms over the longest possible timeframe. Data limit the testing of the StormGuard® standard timing algorithm to the post 1951 interval. The Absolute Momentum and FundX timing algorithms can be tested over even longer intervals.

Chart 2 displays the values of three portfolios over time. The value of a portfolio over time is known as an "equity curve."

Each portfolio was managed by a different timing algorithm. The timing algorithms determined whether the portfolios should be invested in stocks (spliced VFINX) or bonds (spliced VBMFX). Commissions, other transaction costs and taxes were not considered.

Chart 2. Equity Curves for Timed Portfolios of US Stocks and Bonds from 1952.



Source: Monthly Allocations January2017.xlsb; workbook: Summary

It is evident from Chart 2 that there is considerable variation in the performance of the timers. Compare, for example, the separation of the green and black curves over time.

The green and black curves separate between 1952 and the mid 1960s. The implication is that the portfolio managed by the black timer (Absolute Momentum) is underperforming relative to the portfolio managed by the green timer (StormGuard® Standard).

The two curves have drawn together by the year 2000, meaning that the black timer subsequently outperformed the green timer.

These variations are obscured by the long term statistics in Table 1. Each of these timers modestly improved the annualized return as compared to the

return of the unmanaged portfolio. Most importantly, each timer significantly reduced the maximum drawdown and improved the Sharpe ratio.

Table 1. Allocating between Bonds and the S&P 500 Composite, 1952 – 2016[12].

	CAGR	Sharpe	MaxDD
Absolute Momentum	11.48	65	30
StormGuard Standard	11.61	63	30
FundX (VFINX)	12.08	68	23
1:1:1 Composite	11.77	67	27
Unmanaged	10.70	48	51

Plots of relative strength tease out the performance variations obscured by long term statistics. Relative strength in this context is the value of a portfolio managed by one investment strategy divided by to the value of the same portfolio managed by another strategy.

Chart 3 illustrates the relative strength of two intermediate bond funds. The red line is the equity curve for PIMCO Total Return fund (PTTRX) and the green line is the equity curve for Vanguard Total Bond Market (VBMFX). The PIMCO fund has the long term advantage.

The cyan colored relative strength curve demonstrates that the long term advantage of the PIMCO fund is the result of steady, year in year out performance improvement and not the result of exceptional results in a few years. An investor with a long time horizon would almost always have achieved more with PTTRX rather than VBMFX.

[12] "CAGR" is the compounded annual growth rate or annualized return. It is computed as the nth root of the ratio of the current value to the value n years ago, minus 1. The units are percent per year.

"Sharpe ratio" measures the return per unit of return variation. It is computed as the square root of 12 times the average Adjusted Monthly Return divided by the standard deviation of the Adjusted Monthly Returns. Adjusted Monthly Return is the portfolio return less the return of Treasury Bills.

"Drawdown" is the percentage decline in portfolio value from a high (measured at month's end) to a trough (again measured at month's end.) "Maximum drawdown" is the largest decline over the interval.

Chart 3. Relative strength Illustrating Steady Outperformance. PTTRX (red line) versus VBMFX (green line)

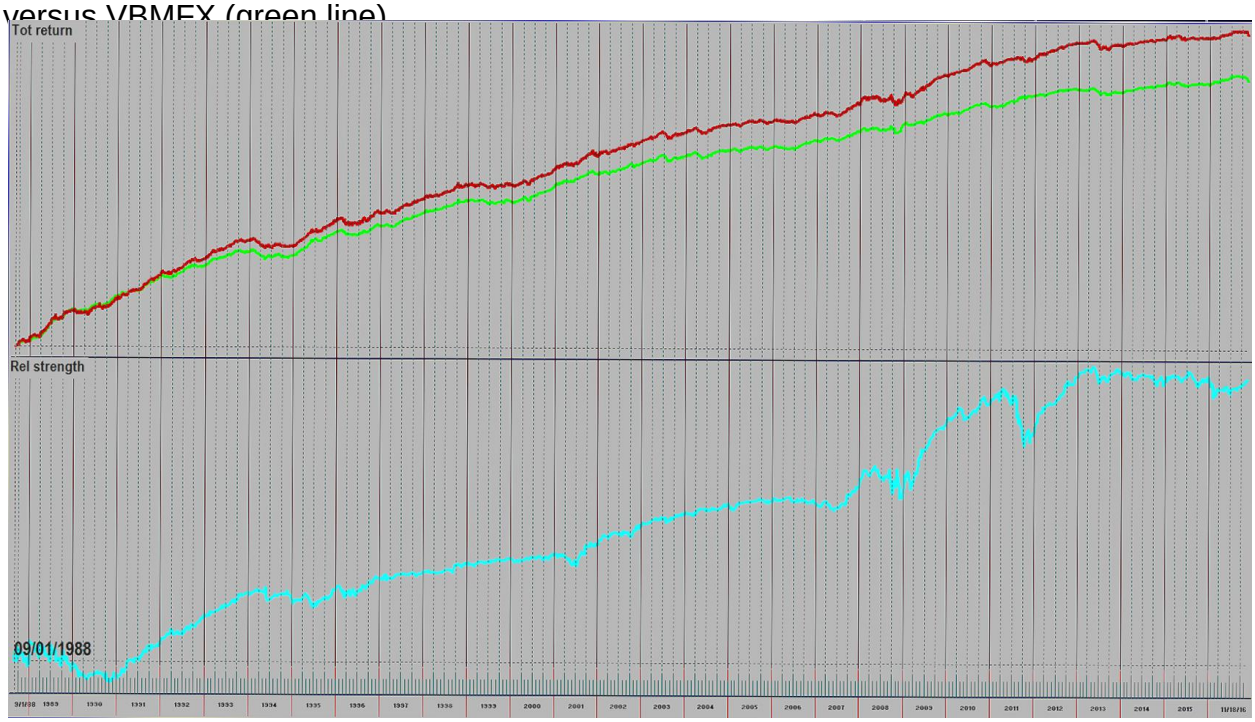


Chart 4 displays the relative strength of FundX as compared to StormGuard® standard. Relative strength in this instance is the value of the FundX managed portfolio divided by the value of the StormGuard® managed portfolio.

The initial value of relative strength is one because the ratios are normalized by the initial values of the managed portfolios. FundX is outperforming when the relative strength is rising.

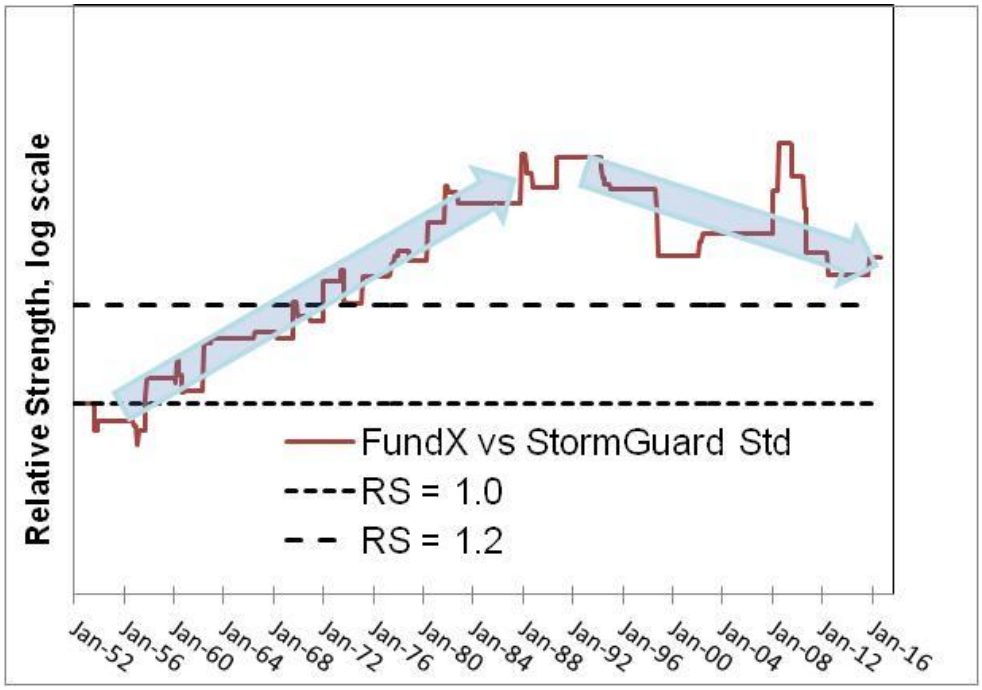
The blue arrows in Chart 4 are meant to suggest that, broadly speaking, the portfolio managed by FundX gained relative to the portfolio managed by StormGuard® standard from 1952 until about 1992, a period of forty years. StormGuard® standard outperformed FundX after 1992.

The vertical movements are large. The horizontal dashed lines represent relative strengths of 1.0 and 1.2 which means that the vertical difference between the dashed lines represents a 20% change in relative values and twice the vertical difference represents a 40% change.

In 1992, the portfolio managed by FundX was 1xx% of the value of the portfolio managed by StormGuard® standard. As of the end of 2016, the value of the portfolio managed by FundX is xx% more than the value of the StormGuard® portfolio.

FundX was the better timer for the first forty years and StormGuard® standard has been the better timer for the most recent twenty-five years.

Chart 4. Relative Strength of FundX versus StormGuard® Standard.



Reference: Monthly Allocations January 2017.xlsb. Workbook "Summary"

Chart 5 displays the relative strength of a portfolio managed by StormGuard® standard as compared to a portfolio managed by Absolute Momentum. StormGuard® standard is outperforming when the relative strength is rising.

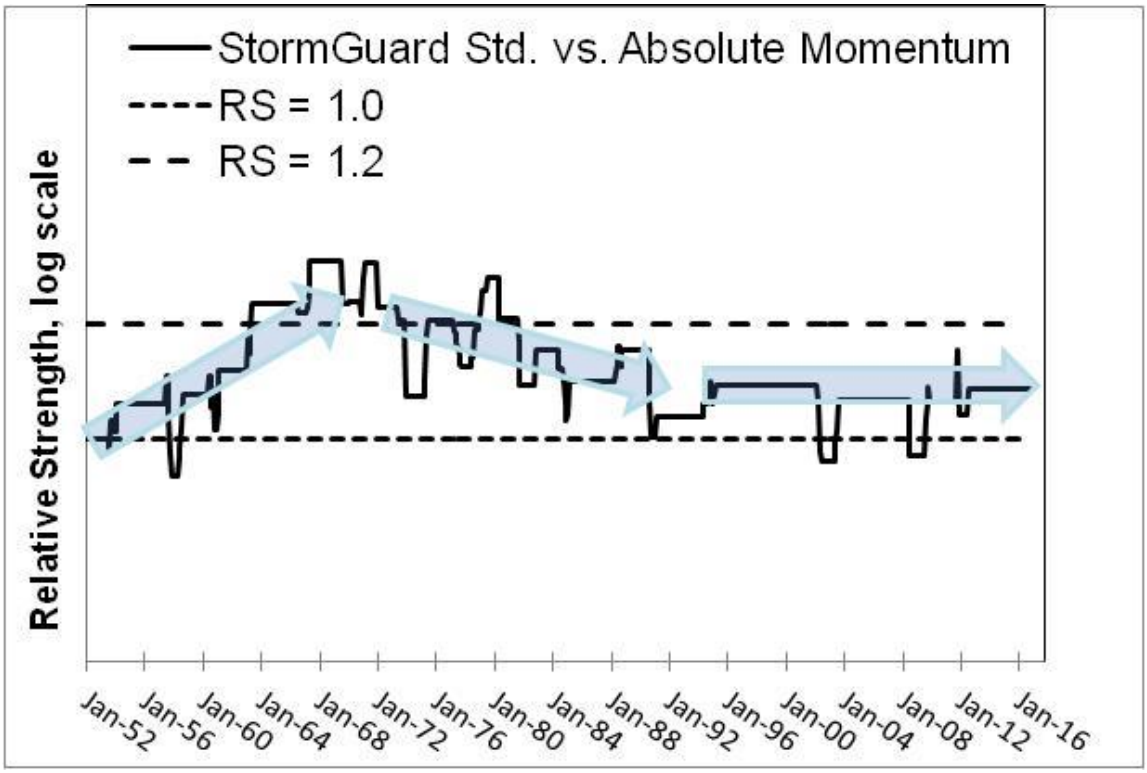
The value of the StormGuard® standard portfolio increases faster than the value of the Absolute Momentum portfolio for about twenty years. The performance then reverses for twenty years. There has been no evident trend with one algorithm being better than the other for the past twenty years.

These charts illustrate that no timer was in the ascendancy over the entire interval. An investor who relied on a one or another timer would have suffered decades of underperformance.

A composite timer reduces the risk of underperformance.

Choosing the timers for a composite is somewhat like constructing a portfolio in that the timers should compensate for each other's deficiencies. FundX and StormGuard®, for example, have complimentary performance profiles over time and make a reasonable combination.

Chart 5. Relative Strength of StormGuard® versus Absolute Momentum.



Source: Monthly Allocations January 2017.xlsb, workgroup Summary

The ultimate goal is for the timer to consistently outperform the benchmark. Consistently exceeding the benchmark is more important than a high long term return which includes extended periods of underperformance.

The purpose of a benchmark is to provide a sense of how an investment strategy would have performed relative to another strategy. Ideally, the benchmark should reflect your investment strategy.

A benchmark of US stocks and bonds is the most complex portfolio that can be formulated from 1952. The following table lists the frequency with which the return of the timed portfolio exceeds the return of a 60% stocks, 40% bonds Benchmark, 1952-2016.

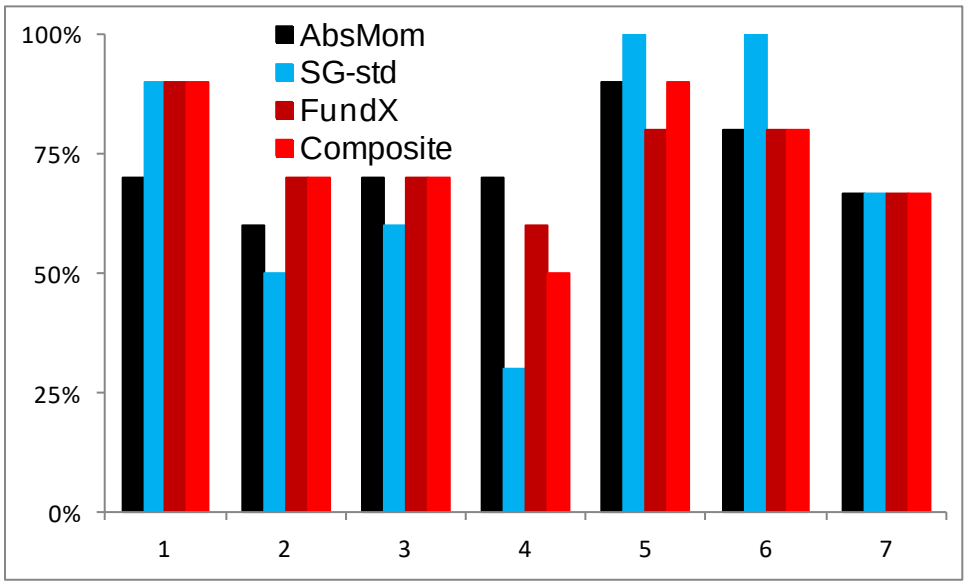
Table 2. Frequency with which the Return of a Timed US Large Cap Portfolio Exceeds the Return of a 60% stocks, 40% bonds Benchmark, 1952-2016.

	FundX Timing	Absolute Momentum	StormGuard® Standard	1:1:1 Composite
1-year	66%	63%	69%	68%
3-years	70%	70%	70%	75%
5-years	86%	70%	79%	79%

Source: Monthly Allocations January 2017.xlsb, workbook Frequency

The following chart illustrates how the frequency of outperformance, averaged over decade long intervals, changes over time.

Chart 6. Frequency With Which the 3-year Return of the Timed Portfolio Matches or Exceeds the 3-year Return of the 60:40 Benchmark. The bars are averages over 1954-63, 1964-73, 1974-83, 1984-93, 1994-2003, 2004-2013 and 2014-2016.



Source: Monthly Allocations January 2017.xlsb. Workbook "Frequency"

The performance differences among the algorithms are especially stark in the fourth interval (1984-1993).

The average frequencies over the past three years – interval 7 – have declined to below the 73-75% averages over the prior sixty years.

It is possible to enhance performance in the fourth decade using more complex timers and by decreasing the trend constant associated with StormGuard® standard. Many investors would find more complex timers difficult to use.

I use the equally weighted composite of Absolute Momentum, FundX and StormGuard® standard timers in the balance of this report because it is an improvement over the individual timers and is easy to implement. To paraphrase an old proverb, don't disparage an improved timing algorithm simply because it is not a perfect timing algorithm.

Long term statistics for several timing algorithms are in Table 3. There are additional timing algorithms but these cannot be evaluated from 1952.

Table 3. Timing US Large Cap Stocks.

1952 – 2016	CAGR	Sharpe	MaxDD	Wins[13]
60:40 Benchmark	9.2	54	33	reference
Absolute Momentum	11.5	65	30	70
StormGuard® Standard	11.6	63	30	70
FundX	12.1	68	23	70
SPVOL[14]	10.8	54	37	81
DR*VOL[15]	11.8	67	23	73
10mSMA (Faber)	11.8	67	23	75
200dSMA, no tolerances	12.4	74	23	76
Golden Cross[16]	11.6	67	30	63
5 mo Absolute Momentum[17]	12.5	75	23	71
StormGuard® Std & SPVOL	11.3	60	27	79
StormGuard® Std & DR*VOL	11.8	66	26	75
Composite	11.8	67	27	75
5 mo Abs Mom, FundX, and StormGuard® Standard	12.1	70	25	75

Source: Monthly Allocations January 2017.xlsb.

[13] "Wins" is the frequency, in percent, with which the 3-year return of the timed portfolio exceeds the 3-year return of the 60:40 benchmark.

[14] Limiting Risk Exposure with S&P Risk Control Indices, February 2012; S&P Indices: Index Mathematics Methodology, January 2012; and S&P Risk Control Indices: Parameters, 5 January 2012. These reports are available at spindices.com.

Russell Investments, Butler *et al*. and Zmyslowski have described similar methods. See Russell Volatility Control Index Series. Construction and Methodology," February 2012.

"Adaptive Asset Allocation: A Primer" by Adam Butler, Michael Phil brick, Rodrigo Gorilla and David Verdi, September 2013. papers.ssrn.com/sol3/papers.cfm?abstract_id=2328254.

Allan J. Zmyslowski, Vol1%SingleEquity.xlsm, AAII Silicon Valley CIMI Group, April 29, 2013.

[15] DEMA50 of the product of the daily return of ^GSPC times its daily volume, normalized by the DEMA50 of the daily volume. The signal is bullish if the indicator is positive.

Gregory Morris describes algorithms of this type in his *The Complete Guide to Market Breadth Indicators: How to Analyze and Evaluate Market Direction and Strength*. The specific form of this algorithm was suggested by John Nicholas and Don Maurer in April 2016.

[16] Golden Cross signals occur when the 50-day SMA of the daily price of the risk index crosses the 200-day SMA of the daily price of the risk index. The signal is bearish if 50SMA is declining at the crossover and bullish if 50SMA is rising at the crossover.

[17] Don Maurer developed this timer. It compares the 5- month total return of US stocks to the 5-month total return of T-bills. This timer is more responsive than the Absolute Momentum timer.

Level3 Portfolios

The "Level3" investor seeks out smaller stocks using fundamental and momentum analysis. He or she prefers equal weighting to capitalization weighting, prefers concentrated to diversified portfolios and holds no defensive securities before retirement[18].

Mr. Cloonan provides several examples of Level3 portfolios: equally weighted US stock indices, real estate, the higher performing AAII screens, the higher performing O'Shaughnessy portfolios[19] and the AAII Shadow Stock portfolio.

Statistics for some Level3-type portfolios have been assembled in Table 4. The annualized returns are higher than the return of the BNY Mellon benchmark but the portfolios are also more volatile. Volatility is evidenced by the modest Sharpe ratios and the large drawdowns.

Table 4. Level3-type Portfolios. Annualized returns for the Wilshire and Russell indices have been reduced by 0.4% to reflect expenses.

1990 – 2016	**CAGR**	**Sharpe**	**MaxDD**
Equal Weight Wilshire 5000	14.4	64	59
40% bonds	11.8	74	39
Composite timing	14.5	80	29
Wilshire 5000 Small Cap Value	11.5	59	55
40% bonds	9.5	69	35
Composite timing	12.0	77	26
Russell MidCap Value (RUM-J)	11.2	61	57
40% bonds	9.2	72	37
Composite timing	12.3	87	21
Real Estate (FRESX)	11.1	50	71
40% bonds	9.5	59	48
Composite timing	12.1	73	32
AAII Shadow Stocks,[20]	16.0	76	63
40% bonds	12.2	86	42
Composite timing	16.5	96	26
BNY Mellon Benchmark[21]	8.2	62	33

[18] *Investing at Level3*, James B. Cloonan, AAII, 2016.

[19] *What Works on Wall Street*, James P. O'Shaughnessy, McGraw-Hill, 2012.

[20] 1993-2016. Charles Rotblut and Wayne Thorp kindly provided the monthly returns. As Mr. Thorpe explains "Actually, the Shadow Stock Portfolio started out as a "Beginner's Portfolio" by Dr. Cloonan that followed the basic tenets of the current Shadow Stock methodology. At the beginning of 2004, he made some additional changes to the portfolio management methodology and it became the Shadow Stock portfolio we are more familiar with today. The performance we report consists of the Beginner's Portfolio until the start of 2004." Source: Data Timers 1952-2016.xlsb, workbook AAII.

The largest risk *when accumulating assets* is the risk of not having saved enough by retirement according to Mr. Cloonan. He is less concerned about volatility because reducing the volatility – adding bonds for example – tends to reduce the return. Anything that reduces the return increases the risk of not having enough at retirement.

Mr. Cloonan is correct in his priorities. Investors may have to accept volatility if they cannot save more, work longer or reduce spending in retirement.

That being said, I worry that a young investor may retreat from equity investments if he loses half of his life savings in his first bear market. This retreat could increase the risk of not having enough at retirement.

My hunch is that more investors would be attracted to Level3 investing if Level3 portfolios were less volatile. As shown in Table 4, momentum based market timing has the potential to reduce volatility and drawdown of Level3-type portfolios without reducing the return.

[21] BNY Mellon compares hundreds of corporate and public pension, foundation, endowment, Taft-Hartley and health care plans (their US Master Trust Universe) to a portfolio of 50% US stocks (Russell 3000, represented here by spliced VFINX), 10% foreign stocks (MSCI World exUS, represented here by spliced HAINX) and 40% bonds (US Aggregate Bond Index, represented here by spliced VBMFX).

The Faber and Siegel Timing Algorithms

Mebane Faber[22] and Jeremy Siegel[23] have published long term tests of timing algorithms. Faber makes decisions based on a 10-month simple moving average (10mSMA) while Siegel makes decisions based on a 200-day simple moving average (200dSMA). Faber found "equity-like returns with bond-like volatility and drawdown" while Siegel concluded that timing reduces volatility but underperforms buy and hold.

Why do two timing systems produce such different results even though they average over similar time frames? The first reason is that is that Siegel makes timing decisions daily whereas Faber, and we, make decisions monthly.

The second reason is that the two timing systems calculate the moving averages of different market indices. Faber measures the moving average of the S&P 500 Composite while Siegel measures the moving average of the thirty stocks in the Dow Jones Industrial Average.

The market index from which a timing algorithm is calculated is known as the "risk index," a term that I borrowed from the S&P lexicon. The risk index matters. The effects of the risk index are explored in Appendix C.

Monthly timing using the 10-month or 200-day simple moving average is competitive with the three timers discussed previously, see Table 3, but they are less easily implemented.

[22] Mebane Faber, Presentation to the San Francisco Chapter of AAII, Berkeley, CA, September 9, 2009; Mebane Faber, "A Quantitative Approach to Tactical Asset Allocation," *Journal of Wealth Management* (2006) as updated 2013. The latter article is available at MebaneFaber.com.

[23] Jeremy J. Siegel, *Stocks for the Long Run*, McGraw-Hill, 5th Edition, 2013, Chapter 20 and Table 20-1.

The SIMPLE Portfolio

Antonacci's Dual Momentum strategy has three elements. The first two elements are his timing and allocation algorithms. The third element is his SIMPLE portfolio: US stocks (represented here by spliced VFINX), foreign stocks (spliced HAINX) and bonds (spliced VBMFX).

It is possible to backtest the SIMPLE portfolio strategy from 1974. What Antonacci found is that the SIMPLE portfolio strategy adds hundreds of basis points to the annualized return, nearly doubles the Sharpe ratio and nearly halves the maximum drawdown.

Table 5. Momentum Management of the SIMPLE Portfolio. Trade on the month-end signal date. The BNY Mellon benchmark is 50% spliced VFINX, 10% spliced HAINX and 40% spliced VBMFX rebalanced monthly. Composite allocation is equal parts Relative Momentum, DEMA6 and FundX.

1974-2016 (43 years)	CAGR	Sharpe	MaxDD
BNY Mellon Benchmark			
No timing	10.0	56	33
Composite timing	11.1	80	14
Relative Momentum Allocation			
Absolute Momentum timing	16.8	92	21
StormGuard® standard timing	16.1	83	24
FundX timing	16.7	90	20
Composite timing	16.6	91	17
Monthly DEMA4 Allocation			
Absolute Momentum timing	16.5	90	21
StormGuard® standard timing	16.2	82	24
FundX timing	16.1	86	19
Composite timing	16.3	89	19
Monthly DEMA6 Allocation			
Absolute Momentum timing	16.8	91	26
StormGuard® standard timing	16.7	85	24
FundX timing	16.8	90	21
Composite timing	16.8	91	18
FundX Allocation			
Absolute Momentum timing	16.2	90	18
StormGuard® standard timing	15.5	79	24
FundX timing	16.0	86	18
Composite timing	16.0	88	18
Composite Allocation and Timing	16.5	92	16
Composite Allocation w/o DEMA6	16.3	90	17

Source: Monthly Allocations January 2017.xlsb

Table 5 illustrates that large improvements in Sharpe ratio and drawdown are achieved by timing the benchmark portfolio. The increase is return is about 160 basis points a year.

This table confirms Antonacci's observation that there is a huge increase in return and improvements in the Sharpe ratio and maximum drawdown as compared to the unmanaged benchmark.

The managed portfolio is about as volatile as the benchmark and has a much lower drawdown. The managed portfolio is thirty percent more volatile than the timed benchmark and has a slightly larger drawdown[24].

Table 5 also includes results for allocation using the FundX allocation algorithm and approximations to the SectorSurfer® allocation algorithm.

It was not possible to apply the SectorSurfer® allocation algorithms directly since the SectorSurfer® trend calculation requires daily returns and daily returns do not exist for US and foreign stocks over so long an interval.

The trends of US and foreign stocks were therefore determined from the double exponential moving averages of the monthly returns of spliced VFINX and of spliced HAINX using a trend constant of four or six months. See Appendix A.

These approximations are identified in the table as "Monthly DEMA4 Allocation" and "Monthly DEMA6 Allocation." Composite allocation is based on equal weighting of FundX, Absolute Momentum and DEMA6.

The new idea in Table 5 is that the performance of the SIMPLE portfolio is not strongly affected by the timing and allocation algorithms employed.

The genius of the SIMPLE portfolio is that it provides excellent results with several timing and allocation algorithms. This portfolio is "Simply Great!"

On the dust jacket for his book, Antonacci claims "an innovative strategy for higher returns and lower risk." It would be more accurate to say that he has identified an innovative *portfolio* which provides higher returns and lower risk with several momentum algorithms.

I had mentioned earlier that investors who find it challenging to determine the values of the DEMA trends could omit DEMA allocation without much effect on the performance of the SIMPLE portfolio. The Table 5 entry "Composite Allocation without DEMA6" demonstrates the truth of this assertion.

The equity curves for the SIMPLE portfolio benefit from both timing and tactical allocation. They are shown in Chart 7. The performance of the three allocation algorithms is not identical. For example, the green equity curve is the lowest of the three early on but ends up near the top forty years later.

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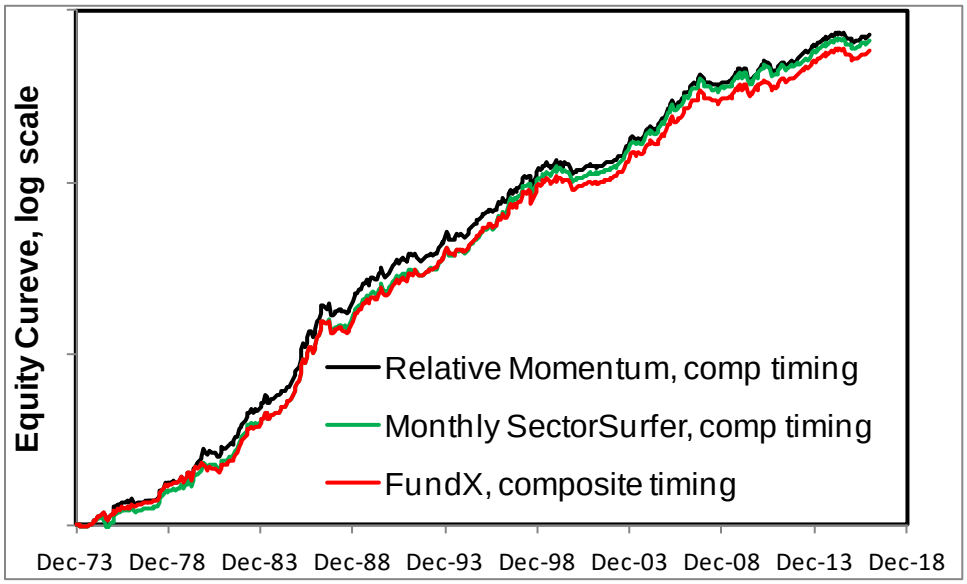
[24] Since the Sharpe ratio is return divided by volatility, the increase in volatility can be assessed as the increase in the Sharpe ratio divided by the increase in return. Comparing the statistics for the timed benchmark and the SIMPLE portfolio with composite timing and allocation, the calculated increase in volatility is 16.5/11.1 divided by 92/80 = 1.29 or about thirty percent.

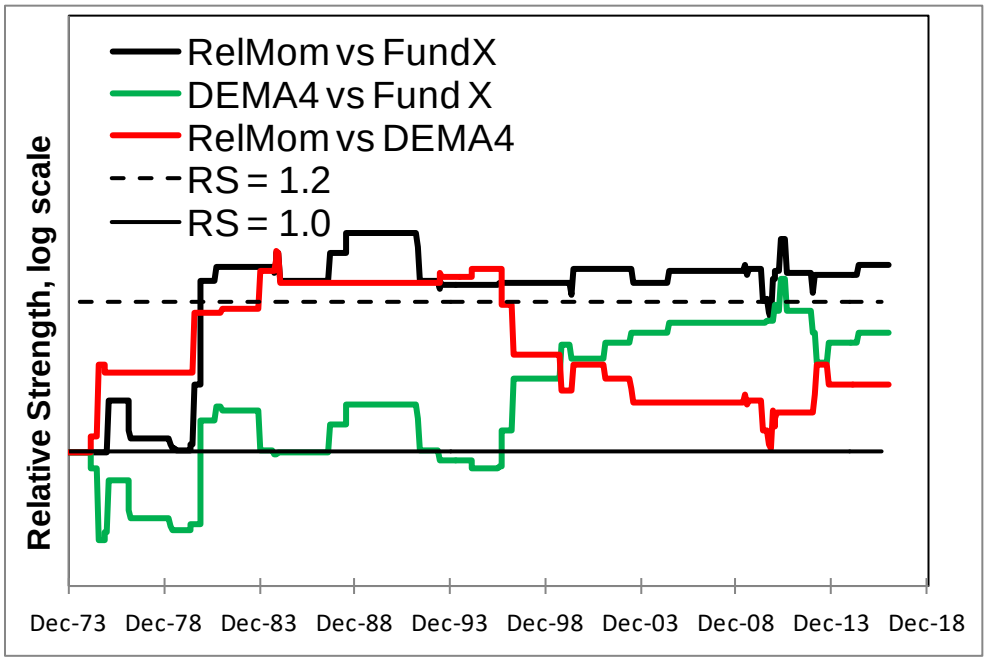
Chart 7. Equity Curves for the SIMPLE Portfolio. Composite timing.



Source: Monthly Allocations January 2017.xlsb, workgroup US&For Frequency

The relative strengths of the managed portfolios with respect to each other are shown in Chart 8. There is considerable variation in relative performance.

Chart 8. Effect of Different Allocation Algorithms on the Relative Strength of Managed SIMPLE Portfolios. Composite timing.



Source: Monthly Allocations January 2017.xlsb, workbook Summary

The variation in performance warrants the use of composite allocation for the SIMPLE portfolio.

What is Composite Allocation?

Each algorithm recommends an allocation over the following month. If using three algorithms, composite allocation means investing one third of the portfolio is the recommendation of each algorithm.

The average of 1 + the return over the following month for each of the recommended allocations equals 1 + the composite return.

Example. The portion of the portfolio managed by algorithm A doubles in value; the portion managed by algorithm B goes to zero and the portion managed by algorithm C is unchanged. The average of 1 + $Return_A$, 1 + $Return_B$ and 1 + $Return_C$ equals one plus the composite return.

((1 + 100%) + (1 - 100%) +(1 + 0%)) / 3 = 1 = 1 + composite return.

The composite return is zero. The value of the composite portfolio is unchanged.

Imagine that $100 is allocated to each algorithm at the beginning of the month. The total portfolio is valued at $300 at the beginning of the month. The value at the end of the month is $200 + $0 + $100 = $300. The portfolio does not change in value over the month.

NoLoad FundX

FundX Investment Group reports the annual performance of several portfolios since June 1980[25]. The portfolios differ by volatility. FundX Investment Group recommends Class 3 for the long term core portfolio.

As shown in Table 6, Class 3 has been less volatile than Classes 1 and 2 over the past 27 years but it has also provided the lowest annualized return.

Table 6. Statistics for NoLoad FundX Portfolios. The SIMPLE portfolio employs composite timing and composite allocation.

1990-2016 (27 years)	CAGR	StdDev	Maximum Annual Loss
Class 1	12.9%	37%	37%
Class 2	13.3%	28%	38%
Class 3	11.3%	18%	40%
BNY Mellon Benchmark	8.2%	11%	23%
SIMPLE portfolio	13.1%	14%	16%

The SIMPLE portfolio with composite timing and allocation achieved a comparable return with a lower standard deviation and lower annual loss.

The black curves in Chart 9 illustrate the relative strength of NoLoad FundX Class 2 and Class 3 portfolios with respect to the BNY Mellon benchmark. The NoLoad FundX managed portfolios have provided three-fold gains relative to the benchmark.

Chart 9. Relative Strength of NoLoad FundX Managed Portfolios, 7/1980 - 2016.

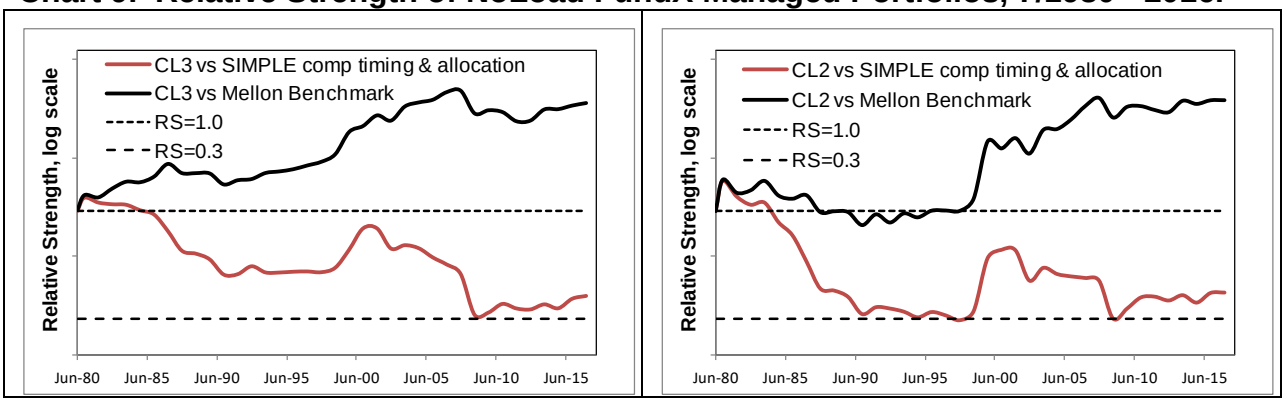


Chart 9 also illustrates the relative strength of NoLoad FundX portfolios relative to the SIMPLE portfolio.

[25] See www.fundx.com/performance.aspx. The returns for 2016 are estimates provided by Jay Matsuda of the FundX Investment Group and may differ from the returns to be calculated by Mark Hulbert.

The SIMPLE portfolio has outperformed the NoLoad FundX portfolios. The 2016 year-end values of both NoLoad FundX portfolios were only about 40% of the value of the SIMPLE portfolio.

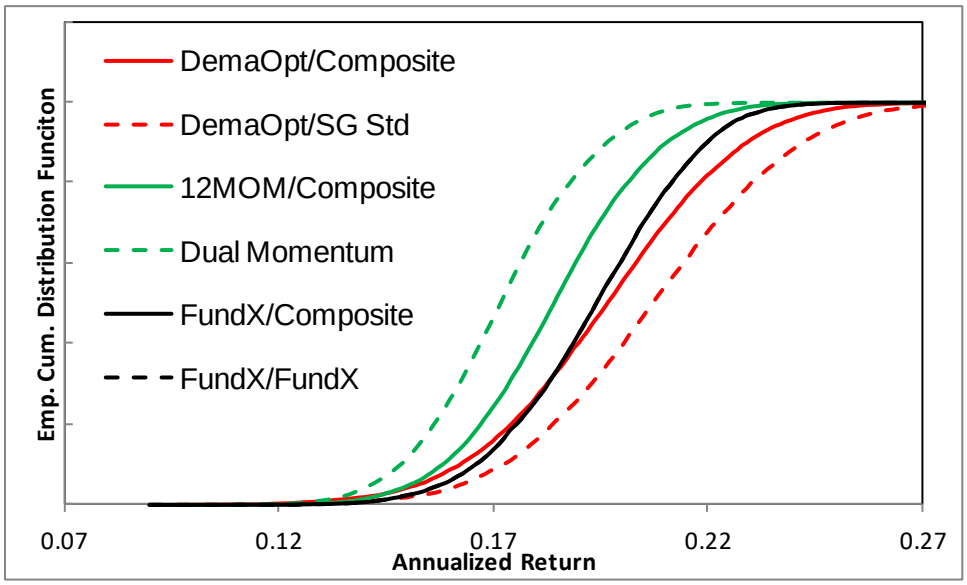
Does Performance Persist?

In 2013, John Nicholas synthesized thousands of portfolios by choosing twelve funds at random from a 32 fund universe[26]. His goal was to create a large number of portfolios which were unaffected by selection bias so that differences in the performance of momentum algorithms would be statistically significant.

Twelve fund portfolios were chosen because that is the maximum number of funds allowed by SectorSurfer®. The 32 fund universe included just about every focused US fund with data from 1988. See Appendix B.

Don Maurer determined performance statistics for thousands of John's portfolios using several algorithms. Don also introduced a "no skill" algorithm in which the monthly allocations of the 12-fund portfolios are determined randomly[27].

Chart 10. Empirical Cumulative Distribution Curves for Ten Thousand 12 of 32 Portfolios Using Different Timing and Allocation Algorithms, 1990-2016. The further that a curve is to the right, the higher its average returns. DemaOpt is analogous to the SectorSurfer® forward walk progressive tuning methodology[28].



Source: ECDS_January 2017.xlsb

[26] John B. Nicholas, "Random Portfolio Selection with Various Timing and Weighting Algorithms," and "Random Portfolio Selection with FundX Momentum and Timing," AAII Silicon Valley CIMI Group, October 1, 2013 and November 4, 2013.

[27] Don Maurer "Use of Random No-Skill Portfolios for Strategy Testing," AAII Silicon Valley CIMI Group, February 4, 2014.

[28] The trend is calculated from daily data and the trend constant is optimized annually based on the returns over the trailing twelve months.

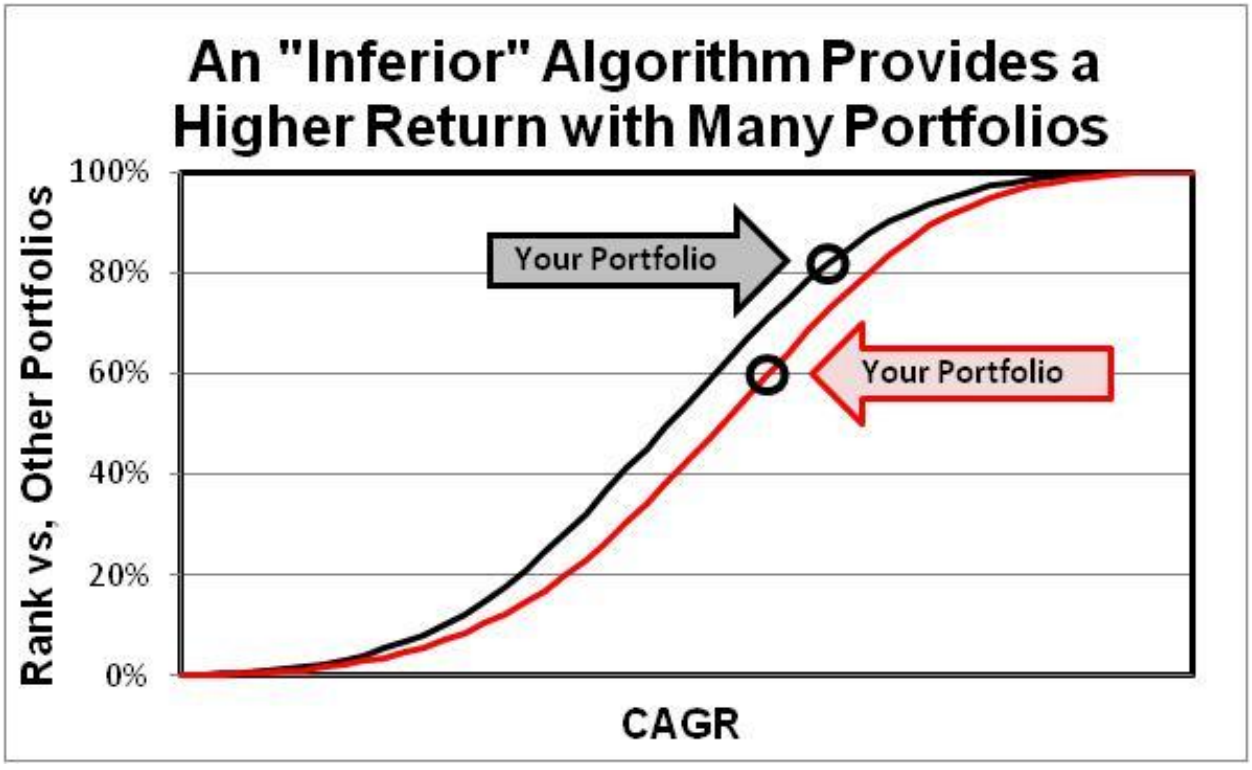
Nicholas and Maurer, and more recently Juds[29], have used this approach to conclude that certain momentum algorithms are better than others. Chart 10 illustrates the sorts of results produced by the Nicholas Maurer approach.

We need to be careful about concluding that one algorithm is better than another. The software provider, with thousands of customers, wants the algorithm which provides better performance for the largest fraction of customer portfolios. The DemaOpt/StormGuard® standard combination may be better than the other algorithms from this perspective.

From the vantage of the individual investor however, differences in the average performance of large numbers of portfolios are not important because many portfolios perform better with an "inferior" algorithm. This is illustrated schematically in Chart 11.

What is important is the performance of an algorithm with his or her portfolio.

Chart 11. Empirical Cumulative Distribution Functions of Two Algorithms. The algorithm which created the distribution plotted in black provides lower returns, on average, than the algorithm which created the distribution plotted in red. However, the black curve provides a higher return for particular portfolios.



The fraction of the random portfolios which excel with a particular algorithm is shown in Table 7. Antonacci has not discussed the performance of the Dual Momentum algorithms with anything more complex than the SIMPLE portfolio.

[29] Scott Juds, "Investment Performance Improvement Utilizing Automated Polymorphic Momentum." This report is available at the NAAIM website www.naaim.org/programs/find-a-whitepaper.

Some algorithms provided more top returns than the others but no algorithm provided the top return for all portfolios. The decision for the individual investor is not "Which is the best algorithm?" but rather "Which is the best portfolio for the algorithm used by my software provider?"

Table 7. Frequency of Best Returns, 1990-2016. The annualized returns of a portfolio using one algorithm was compared to the returns of the same portfolio using other algorithms. If two returns agreed to within 0.002, the returns were considered a "tie." The statistics are based on ten thousand portfolios. The percentages in the table do not sum to 100% due to ties.

Timing Algorithm / Allocation Algorithm	Composite Timing	Absolute Momentum	FundX Timing	StormGuard Standard
Relative Momentum	16	6		
FundX	42		17	
DemaOpt	51			82

Source: ECDFs_January 2017.xlsb

The compositions of the superior portfolios for the algorithm used by a particular software provider are usually identified by backtesting. Identifying a portfolio by backtesting implicitly assumes that the superior performance persists into the future.

Backtesting is a high risk way to try to identify the 12-fund portfolios which will provide superior performance in the future. This was shown by identifying a large number of portfolios with superior returns over fourteen years and testing the subsequent performance of these portfolios.

Superior returns over a fourteen year backtesting interval do not guarantee superior returns over the next dozen years. Rather, subsequent returns are about equally distributed from superior to poor and there is a fifty percent chance that the future return of a superior portfolio will be below average.

The subsequent return distributions are shown in Table 8. The returns of the superior portfolios ranked in the top 20% of the returns of all ten thousand portfolios.

The NoSkill algorithm processed the same ten thousand 12-fund portfolios. The difference is that the monthly allocation was random and not determined by the trends of the funds. The NoSkill algorithm provides the same number of subsequent returns in each quintile. This is to be expected since the subsequent returns are randomly related to the prior returns.

Table 8. Subsequent Return Distribution, 2004-2016, of the 12 of 32-Fund Portfolios with the Highest Returns During the Backtest Interval 1990-2003. Allocation is to the fund with the highest trend and trades are on the day after the month-end signal date. Totals may not equal 100% due to rounding.

	Bottom Half	Top 20%	2nd Quintile	3rd Quintile	4th Quintile	Bottom 20%
NoSkill (random), Composite timing	50	20	19	19	21	20
Relative Momentum, Composite timing	43	23	23	21	19	14
Dual Momentum	44	24	22	21	18	15
FundX, Composite timing	43	23	23	21	19	14
FundX, FundX timing	44	24	22	21	18	15
Dema20 Composite timing	56	14	19	23	27	17
Dema20, StormGuard® Std	58	14	18	22	26	20
DemaOpt, Composite timing	56	17	17	22	23	21
DEMAopt, StormGuard Std.	57	16	17	20	24	22

Source: Persistence January 2017.xlsb

The subsequent returns for the Dual Momentum, FundX and DEMA algorithms are about equally distributed in each quintile. The conclusion is that the subsequent returns of the superior 12-fund portfolios bear little relationship to the returns in the backtesting interval. The implication is that there is a fifty percent risk that a superior 12-fund portfolio will provide below average returns in the future.

The simulations identified the funds which contributed the most to the return in the two intervals. The most important funds in the backtest interval are different from the most important funds in the subsequent interval.

Back testing identifies the funds that were important in the past but it cannot identify the funds that will be important in the future. Backtesting risks the omission of funds that will be important in the future.

"Selection bias" occurs when funds are excluded from the future portfolio solely because they were not important in the backtesting. Selection bias is more

likely when there is a limit on the number of candidate funds and/or when the candidate funds have limited histories.

The solution to selection bias is straightforward. Do not limit the fund choices available to the simulator. As a practical matter, this means allowing the simulator to choose from a large number of plausible funds.

The SIMPLE portfolio includes a broadly diversified portfolio of US and foreign stocks but there is one omission.

The total value of global equity markets is on the order of $50T USD, split about equally between the US and ex-US. The total value of professionally managed global real estate is about $7T USD in 2015 while investable real estate is on the order of $80T USD[30].

Although real estate is comparable in size to global equity markets, real estate - in the form of REITs primarily - represents only a fraction of global equity indices.

The SIMPLE portfolio risks selection bias because it under weights real estate. The SIMPLE portfolio would be expanded to include real estate.

A portfolio of focused US sectors should include all reasonable possibilities, on the order of 30 funds.

A focused global portfolio should include many more than 30 funds.

Portfolios with more than a hundred choices do not present computational difficulties.

Possible US and global focused portfolios are described in Appendix B.

[30] Dow Jones Indices, 2016 and Value Walk, January 2016; MSCI, June 2016 and Value Walk, January 2016.

Be Realistic in Your Expectations

My impression on hearing Scott Juds' presentation for the first time was that the engineering principles on which SectorSurfer® is built can distinguish the trends in financial markets from the associated financial noise with the same accuracy as the telephone companies can distinguish the sound of the human voice from the associated electronic noise. This was a misconception.

Algorithms are better at identifying whether the equity market is going up or down over the coming month than random guesswork but the algorithms are a long way from perfect.

If an accurate timing prediction is defined as the US equity market rising faster than the bond market after predicting a rising equity market, or falling more than the bond market after predicting a declining US equity market, then the accuracy of these timing algorithms is on the order of 71 – 74%.

If we exclude months with small changes, the accuracy is on the order of 80%.

The return of US stocks exceeded the return of bonds in 58% of these months. The NoSkill timing algorithm picks a random number each month between 1 and 100. If the random number is 58 or less, the algorithm allocates to stocks. If the random number is more than 58, the allocation is to bonds.

Comparing actual monthly performance to 10,000 realizations of the NoSkill algorithm shows that the accuracy of the NoSkill algorithm is about 51%.

The deviation from the theoretical 50% accuracy may be due to the fact that there are only 324 actual monthly observations.

Table 9. Accuracy, 1990-2016. Timing accuracies are the same for all portfolios which make independent timing and allocation decisions. Allocation accuracies are for the SIMPLE portfolio (VFINX, HAINX and VBMFX) and were measured without timing.

NoSkill Timing	Absolute Momentum	FundX Timing	StormGuard® Standard
51 ± 2.7	70.6	70.9	74.3
Random Allocation	**Relative Momentum**	**FundX Allocation**	**DEMA70 Allocation[31]**
50	52.9	52.6	53.9

Source: Accuracy of SIMPLE Predictions.xlsb

If an accurate allocation prediction is defined as the US market rising faster than foreign markets in the month after predicting a rising US market, or foreign markets rising faster than the US market in the month after predicting rising foreign markets, the accuracy of these allocation algorithms is 53 – 54%.

[31] Trends are calculated as DEMA of the daily returns with a trend constant of 70 days. This daily algorithm corresponds to the monthly DEMA4 used previously. See Appendix A.

Guessing the allocation would provide an accuracy of 50% averaged over many months.

With the SIMPLE portfolio plus real estate, the accuracy of the allocation algorithms is 40 – 43%.

With a portfolio of 32 US sector funds, the allocation accuracy is on the order of 10%.

There will be many months in which the algorithms will provide the wrong signals. For example, the timing signals at the end of September 2015 were to go to cash. The market rose sharply during October 2015.

More Complex Portfolios

This section discusses the effects of adding real estate to the SIMPLE portfolio, the performance of portfolios containing many focused US sector funds and the effects of allocation to more than one fund[32].

Table 10. Momentum Management of the SIMPLE Portfolio plus Real Estate. Trade on the month-end signal date. The BNY-Mellon benchmark contains 50% spliced VFINX, 10% spliced HAINX and 40% spliced VBMFX. There was allocation to the top trending fund or equal allocation to the top two trending funds.

1974 – 2016	CAGR	Sharpe	Max DD
BNY Mellon Benchmark	10.0	56	33
Relative Momentum Allocation			
Absolute Momentum timing	16.3	87	22
Composite timing	16.2	87	16
Composite timing, top 2	15.9	94	21
Monthly DEMA4 Allocation			
StormGuard® standard timing	17.5	89	24
Composite timing	17.9	97	17
Composite timing, top 2	15.8	94	21
FundX Allocation			
FundX timing	16.4	85	17
Composite timing	16.2	85	17
Composite timing, top 2	15.4	92	21
Composite allocation and timing			
US and foreign stocks	16.3	90	18
US, foreign and real estate stocks	16.8	92	16
US, foreign and real estate, top2	15.7	94	21

Source: Monthly Allocations January 2017.xlsb

Table 10 summarizes the statistics for the SIMPLE portfolio plus real estate (in the form of spliced FRESX). Real estate provides modest improvements to the return, Sharpe ratio and maximum drawdown. The primary benefit is that including real estate reduces the risk of selection bias.

With three equity funds, it is possible to allocate to the top trending fund or to the top two trending funds. When allocating to the top two funds, the portfolio would contain VFINX and FRESX or HAINX or FRESX or VFINX and HAINX when the market is quiescent.

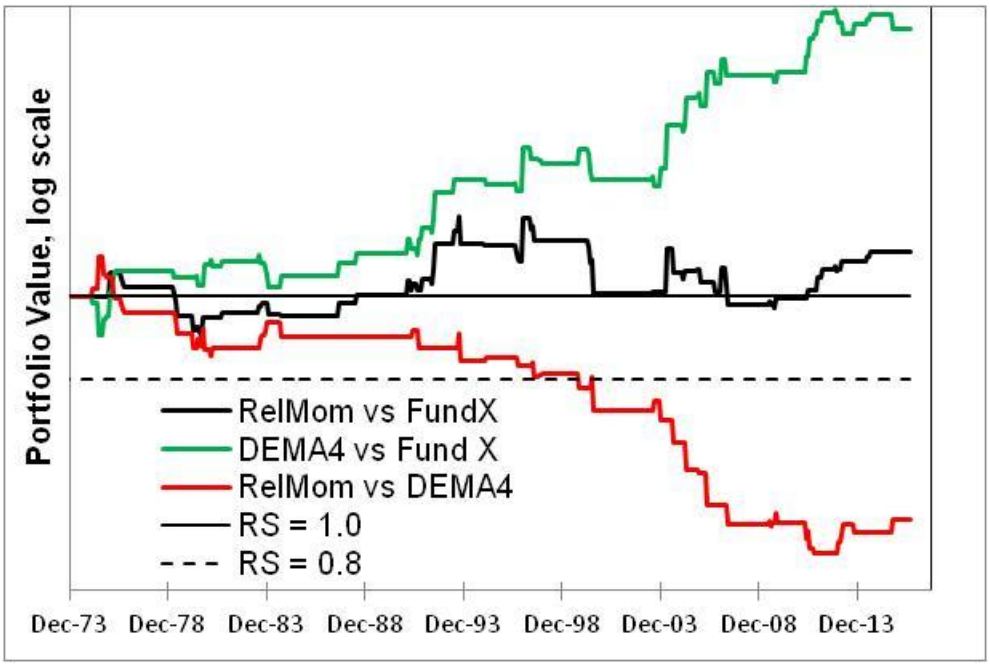
The portfolio would contain VBMFX when the market is in turmoil.

[32] John Nicholas has previously tested allocation to more than one fund in the contest of the FundX algorithm. See JBN_AAII_Nov_Meeting.pdf, AAII Silicon Valley CIMI, 131104 Meeting.

Allocating to the top two funds reduces the return for all algorithms and increases the Sharpe ratio for two of the algorithms. The reduction is volatility is greater than the reduction in the return.

The relative strengths of the algorithms are displayed in Chart 12. The DEMA4 SectorSurfer® approximation has outperformed Relative Momentum and FundX since about 1990. Allocation based on the recommendations of all three timers is again seen to be lower risk than relying on one algorithm alone.

Chart 12. Relative Strength of the SIMPLE Portfolios plus Real Estate with respect to Each Other.



Source: Monthly Allocations January 2017.xlsb

The effects of including real estate and of allocating to the top two funds are similar since 1990. Compare Table 11. Including real estate and allocating to the top two funds would not have made much practical difference to the performance of the SIMPLE portfolio.

Table 11. Allocating to the Top Two Trending Funds, 1990-2016. Trade on the signal date. The equity allocation is the average recommendation of the Relative Momentum, FundX and DEMA algorithms; composite timing.

1990 - 2016	CAGR	Sharpe	Max DD
SIMPLE portfolio	13.1	86	18
SIMPLE portfolio plus Real Estate	13.7	90	16
With Real Estate and Top 2 Allocation	13.4	96	15

Source: Monthly Allocations January 2017.xlsb

Table 13 summarizes statistics for a portfolio of many US sector funds.

Table 13. Simulations of Narrowly Focused US Funds. These results are "deterministic;" that is, they did not involve random portfolios or random allocations. Allocation is to the top trending fund, composite timing is used and trades are on the day after the signal date.

The 28 and 32 fund universes are described in Appendix B.

1990 – 2016	CAGR	Sharpe	MaxDD	Rank
BNY-Mellon Benchmark	8.2	59	35	
Relative Momentum allocation				
28 funds	16.1	66	29	71%
32 funds	18.4	69	32	25%
FundX allocation				
28 funds	19.5	78	39	33%
32 funds	18.6	70	39	49%
DemaOpt allocation				
28 funds	21.9	88	34	10%
32 funds	22.7	87	46	5%
Composite allocation				
28 funds	19.5	82	28	
32 funds	20.4	81	33	
Dema20 allocation				
28 funds	22.8	89	34	8%
32 funds	20.9	78	34	28%

Sources: 28 & 32 Deterministic January 2017.xlsb; 12of32 Jan 2017.xlsb; 12of32 DemaOpt January 2017.xls

Momentum strategies provide larger returns with focused multi-fund portfolios than with the SIMPLE portfolio. However, the returns are more volatile and exhibit larger drawdowns and a spreadsheet is needed to calculate the allocation signals.

For a portfolio of 28 funds, composite allocation improves the statistics of the Relative Momentum and FundX allocation algorithms but degrades the return and Sharpe ratio of the DEMAopt algorithm. Another way of saying the same thing is to note that the performance statistics for DemaOpt exceed those for the Relative Momentum and FundX allocation algorithms.

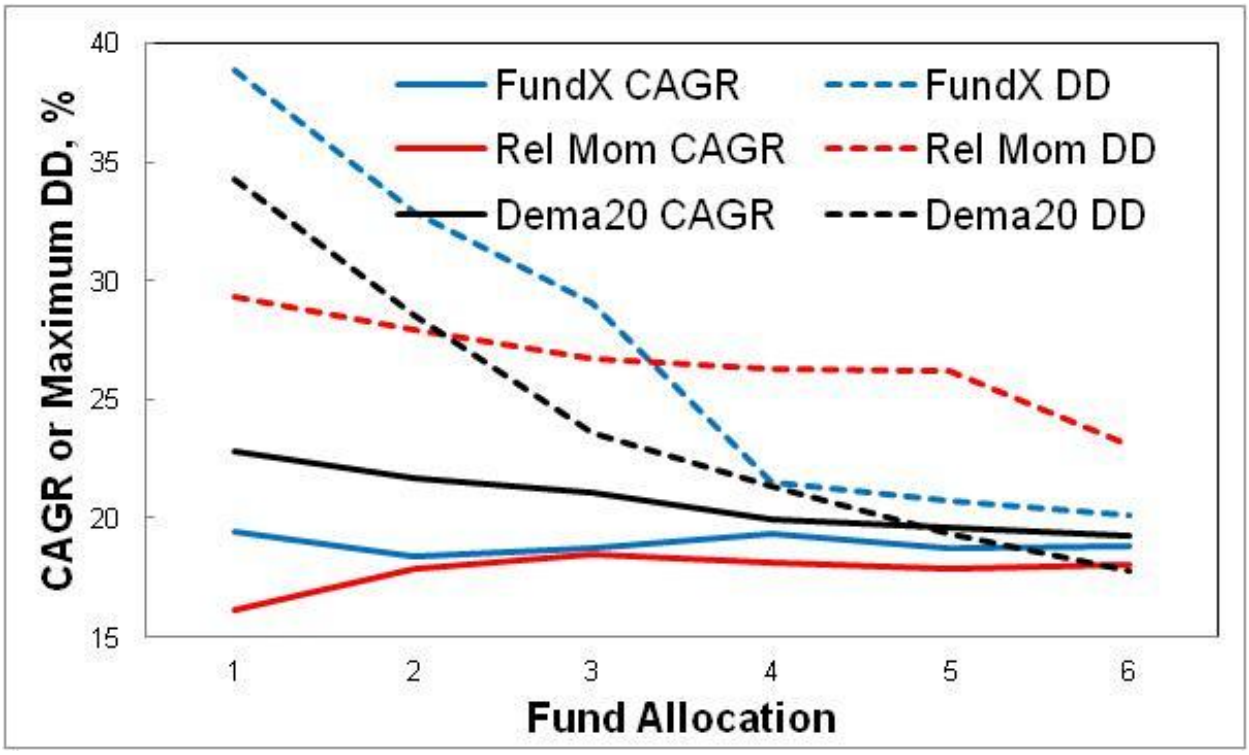
For a portfolio of 32 funds, composite allocation improves the returns and Sharpe ratios of the Relative Momentum and FundX allocation algorithms and improves the drawdown of the DemaOpt algorithm but degrades the return and Sharpe ratio of the DemaOpt algorithm.

"Rank" indicates the ability of the algorithm to identify the top performing funds from among the 32 possibilities. The DemaOpt and Dema20 algorithms do very well, achieving a return which is larger than most of the ten thousand 12 of 32-fund portfolios.

The FundX and Relative Momentum algorithms are less effective at identifying the top trending funds.

The drawdowns shown in Table 13 are probably not acceptable to the risk adverse investor. However, drawdowns can be reduced by allocating to more than the top fund. This is illustrated in Chart 13.

Chart 13. Reduce Drawdown by Allocating to Several Funds, 1990-2016. Twenty-eight fund universe, composite timing. Trade on the day after the signal date.



It is beneficial to allocate to several stocks when using these algorithms to manage a portfolio of the hundred stocks in the NASDAQ 100 index.

It is tempting to conclude that DemaOpt and Dema20 are superior to the other allocation algorithms for the 28 fund universe. However, multi-fund portfolios can only be backtested from 1990. Chart 8 shows that the DEMA algorithm excels (for the SIMPLE portfolio) from the mid 1990s through the mid 2000s but that the DEMA algorithm is unexceptional before and after this interval.

Table 14. Simulations of 28 Funds. These results are "deterministic;" that is, they did not involve random portfolios or random allocations. Composite timing; trades are on the day after the signal date.

The first columns correspond to equal allocation to N funds. The second columns correspond to weighting allocations inversely by 60-day standard deviations.

1990 – 2016	**CAGR**		**Sharpe**		**MaxDD**	
BNY-Mellon Benchmark	8.2		59		35	
FundX allocation						
Top 2	18.4		82		33	
Top 4	19.4	18.8	96	96	22	21
Top 5	18.7		96		21	
Top 6	18.8	18.4	99	101	20	20
Relative Momentum allocation						
Top 2	17.9		80		28	
Top 4	18.1	17.8	87	87	26	24
Top 5	17.9		90		26	
Top 6	18.1	17.8	94	97	23	20
Dema20 allocation						
Top 2	21.7		96		29	
Top 4	20.0	19.6	104	106	21	20
Top 5	19.6		106		19	
Top 6	19.3	19.2	108	112	18	17
FundX and Dema20 allocation						
Top 4	19.7	19.3	102	103	20	20
Top 5	19.2		103		19	
Top 6	19.1	18.8	106	109	18	18
Relative Momentum, FundX and Dema20 allocation						
Top 2	19.5		90		25	
Top 4	19.2	18.8	98	99	21	20
Top 5	18.8		99		19	
Top 6	18.8	18.5	103	106	18	18

Source: 28 Deterministic January 2017.xlsb

The multi-fund portfolios discussed here are constructed of funds with a narrow investment focus. This was because my goal had been to employ index-like funds that follow the same investment strategy indefinitely.

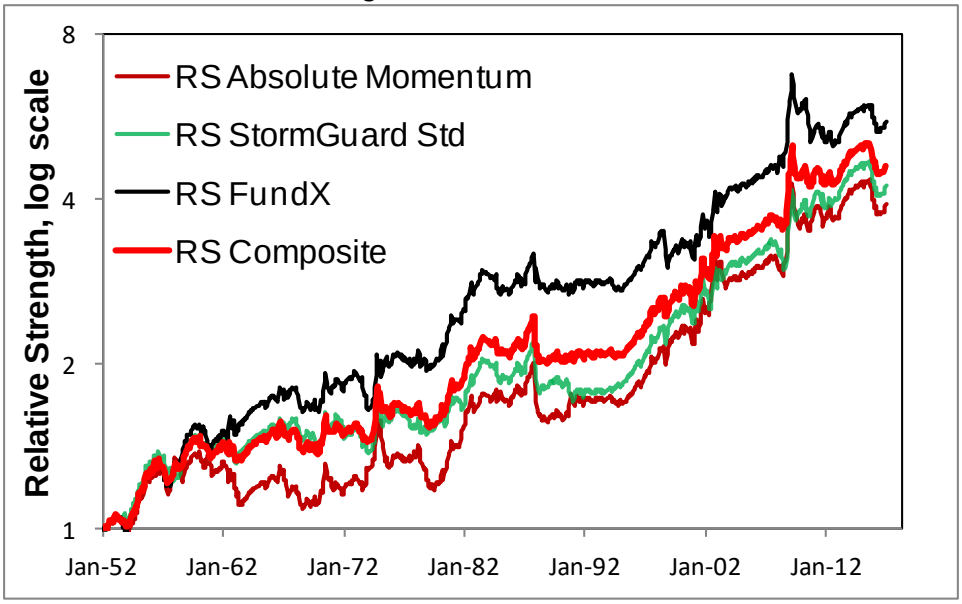
This goal was influenced by the fact that my investment universe was limited to twelve funds.

Having shown that the simulator performs well with many funds and that it can distinguish between important and unimportant funds, the investment

universe could be expanded to include funds with amorphous objectives. It would be interesting to know how such an augmented universe would perform.

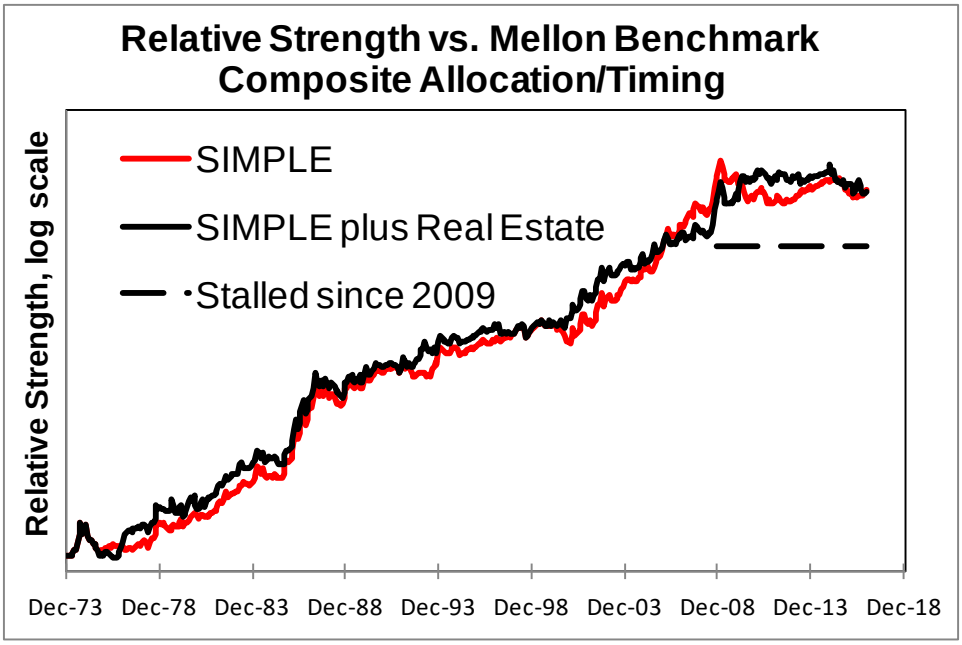
Why Has Recent Momentum Performance Been Disappointing?

Chart 14. Relative Strength of Timed Portfolios of US Large Cap Stocks versus 60:40 Benchmark. Trade on the signal date.



Source: Monthly allocations January 2018. Worksheet Frequency

Chart 15. Relative Strength of Timing plus Tactical Allocation. Trade on the signal date. Performance has been stalled since about the end of 2008.



Source: Monthly allocations January 2018. Worksheet Summary

Portfolio Visualizer's Implementation of "Dual Momentum

Portfolio Visualization[33] has implemented the "How to Use It" version of Dual Momentum that Antonacci describes in Figure 8.4 of his book. Antonacci used the "2-step" method, described on p. 98, when constructing his figures and tables.

The How to Use It method underperforms as can be seen in the following table. Trades are on the month-end signal dates.

12/29/1989 – 12/31/2016	CAGR	Sharpe	MaxDD
SIMPLE portfolio: VFINX, HAINX and VBMFX			
Portfolio Visualizer	11.7	71	25
2-Step	13.1	84	21
28 Fidelity Select Funds, top 1			
Portfolio Visualizer	14.6	56	41
2-Step	14.9	59	38
28 Fidelity Select Funds, top 6			
Portfolio Visualizer	16.2	77	35
2-Step	17.3	90	23

Source: PoerfolioVisualizer.xlsx

The explanation for the lower performance of Portfolio Visualizer with the SIMPLE portfolio is that the How to Use It method allocates to foreign stocks in sixteen months when the 2-step method allocates to bonds.

I did not compare monthly allocations with the 28 Fidelity fund universe.

Two monthly returns for VFINX differ between the Portfolio Visualization data set and those determined using Investors FastTrack data. The differences are likely related to the date on which the $0.56 December 1992 dividend is posted. Yahoo.com (and apparently Portfolio Visualizer) posts the dividend on December 31, 1992 while Investors FastTrack posts the dividend on January 4, 1993. I do not know which is correct. The posting date uncertainty does not affect the long term return and the performance statistics.

I recomputed the performance statistics from the monthly Portfolio Visualizer equity curves but I need not have bothered as my results were the same as the statistics reported by Portfolio Visualizer – an encouraging sign.

It is hoped that Portfolio Visualizer can be encouraged to move to the higher performing 2-step algorithms as this would allow investors to manage multi-fund portfolios using Dual Momentum.

[33] Portfoliovisualizer.com, a free service.

Other Considerations

You may have noticed that trades occurred on the signal date in some of the simulations and on the day after the single date in others. It is only possible to trade on the month-end signal date in simulations before 1990 as the data are only available at monthly intervals. Trading on the day after the signal date is likely to be more realistic for many investors.

You probably did not notice that I used different simulators with the monthly and daily data.

What are the effects of trading on the signal date as opposed to the day after the signal date and what are the differences in the results of the two simulators? Table 12 investigates.

Changing the trade date produces small differences in the returns and other statistics. The direction of the changes is not the same for all algorithms.

Table 12. Effects of Simulator and Trade Date, SIMPLE Portfolio. Stocks are represented by spliced VFINX and by spliced HAINX and bonds are represented by spliced VBMFX. DEMA4 measures the trend based on monthly data and a 4 month trend constant. DEMA70 measures the trend based on daily data and a 70 day trend constant.

1990 – June 2016	CAGR	Sharpe	Max DD
FundX & composite timing			
EXCEL, trade same day	12.95	84.5	17.6
C#, trade same day	12.95	82.6	17.6
C#, trade next day	12.87	83.5	18.7
Relative Momentum & composite timing			
EXCEL, same day	12.79	82.4	17.3
C#, same day	12.79	82.4	17.3
C#, next day	12.94	83.7	18.1
DEMA & composite timing			
EXCEL, DEMA4, same day	13.31	85.7	19.0
C#, DEMA70, same day	13.48	87.2	16.7
C#, DEMA70, next day	13.31	86.5	17.1

Source: Monthly Allocations 1952-2016 revised 09132016.xlsb; Deterministic 09162016.xlsb, workbook "2 Funds".

There are modest differences in return, Sharpe ratio and drawdown between the simulators for the DEMA algorithm. The EXCEL simulator uses the monthly DEMA approximation with a 4 month trend constant while the C# simulator uses the daily DEMA algorithm with a trend constant of 70 days.

I have neglected the effects of simulator and trade date since the differences are small in comparison to the performance gains associated with momentum management.

The performance of a managed portfolio is often reduced by an estimate of trading costs. While it is appropriate to correct for trading costs, the correction should employ an estimate of future costs. Our goal, after all, is to estimate how the algorithm might perform if historical market conditions were to reappear in the future.

There is usually no commission associated with exchanging one mutual fund for another in the same family.

Selling an exchange traded fund and buying another involves a commission of less than $20, which is only 0.02% on a hundred thousand dollar portfolio.

FolioInvesting.com allows investors 2,000 "window" trades of stocks, mutual funds and ETFs each month for a $290 annual fee. The commission is $3 per trade for market, limit, stop and stop limit orders. Vanguard charges a $2 per trade for investors with account balances of $500.000 or more.

More important are the effects of intra-day price movements and of bid-ask spreads. Intra-day price movements can be a half percent or more for or against your positions but these intra-day price movements should average out over many trades.

The bid ask spread for liquid, index-like exchange traded funds (VTI, VEU, VNQ and BND) is on the order of 0.02% per round trip. The spread is on the order of 0.1% per round trip for the NASDAQ 100 components[34]. Bid ask-spreads reduce returns by a negligible amount for the SIMPLE and 28-fund universes assuming that they are implemented with funds or ETFs and by about 1% a year for the NASDAQ 100 universe.

Trading costs appropriately include any tax liability or benefit resulting from the trade. There is no current tax liability or benefit if the trade occurs in an IRA, 401k or 403b account.

My conclusion is that trading costs do not diminish in any substantive way the potential gains from the momentum strategies discussed here.

Some mutual funds impose frequent trading fees. Holding for less than 30 calendar days costs 0.75% for some Fidelity funds. This is seldom an issue if trading on the last day of the month. Vanguard makes it difficult to repurchase a Vanguard fund which was sold within 30 or 60 calendar days previously.

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[34] Allan Zmyslowski illustrated an easy way to harvest bid-ask spreads at the December 1, 2016 CIMI meeting. Using his approach, bid-ask spreads were measured at six approximately hourly intervals from 1030 EST on December 8, 2016 to 1534 EST on the same date. The average spread for liquid ETFs was 0.015% and for the NASDAQ 100 components was 0.042%. Source: YahooQuotes.xlsm.

The average spread is about the round trip cost since one pays half of the spread at the time of purchase and another half of the spread at the time of sale.

I readily acknowledge that one day of measurements is not sufficient to fully define the spreads.

Conclusions

- Each of three timing algorithms underperformed the others for decade long intervals. The recommendation is to reduce the risk of underperformance by employing a composite based on several timing algorithms.
- Performance statistics for the SIMPLE portfolio are not strongly affected by the allocation algorithm. A composite of several allocation algorithms is recommended for the SIMPLE portfolio.

  The inclusion of the DEMA algorithm is not essential for the SIMPLE portfolio but DEMA is advantageous for more complex portfolios.
- The SIMPLE portfolio provides more return with less risk than many benchmarks and other strategies.

1990 – 2016	**CAGR**	**Sharpe**	**MaxDD**
Unmanaged S&P 500®	9.3	49	51
SIMPLE	13.1	86	18
SIMPLE plus REITs, top 2 funds	13.4	96	15
SectorSurfer®, SIMPLE plus REITs	16.3	97	23
Wellington™, VWELX, 33% bonds			
BNY-Mellon Benchmark, 40% bonds	8.2	62	33
Wellesley Income, 65% bonds	8.6	90	19
S&P 500® Dividend Aristocrats®	11.4	68	44
Shadow Stocks, 1993-2016 with composite timing	16.0 16.5	76 96	63 26
28 US funds, composite timing and allocation, equal weight top6	18.8	103	18

- The SIMPLE portfolio is easily managed and should provide substantial performance gains for risk adverse investors.
- Selection Bias is reduced by building inclusive portfolios of many funds.
- Drawdown is reduced by allocating to more than a single fund.

Acknowledgement

It is said that progress comes from standing on the shoulders of others. Peter salutes Scott Juds, Don Maurer, John Nicholas and Al Zmyslowski for their considerable assistance.

Appendices

A. Determining the DEMA Trend

B. The 32 and 74-Fund Opportunity Sets

C. The Risk Index

Appendix A. Determining the DEMA Trend

SectorSurfer® uses double exponential moving averages (DEMA).

The calculation of the exponential moving average of daily returns is algebraically equivalent to calculating the weighted sum of the daily returns.

$$EMA = \sum W(red) * Daily\ Return$$

The weights are given by the red line in Chart A-1.

The red weights are “exponential" because the values of the weights approximate the exponential $e^{-\alpha t}$, where t is the number of market days before the measurement date and α is a smoothing factor.

A double exponential moving average is the exponential moving average of the exponential moving average.

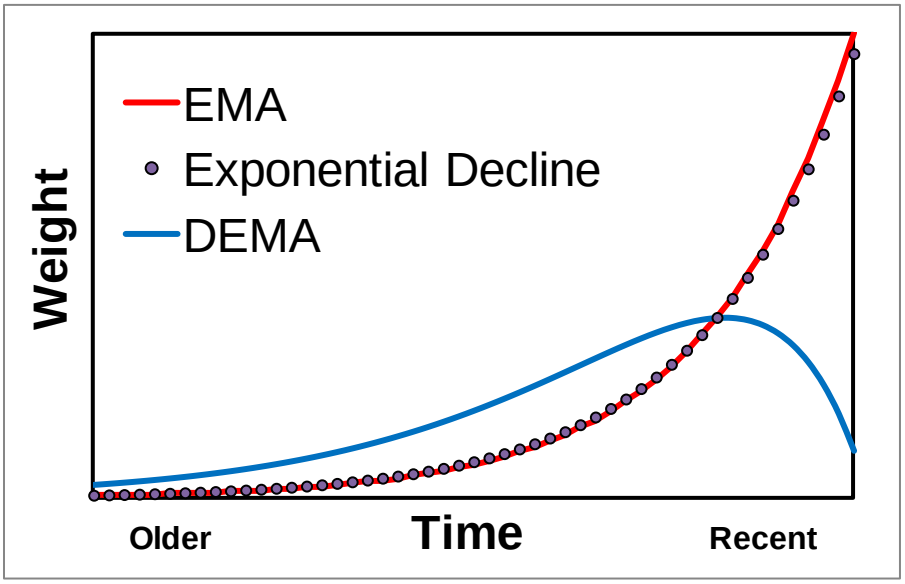
$$DEMA = \sum W(red) * \sum W(red) * Daily\ Return$$

The double exponential moving average is equivalent to the weighted sum of the daily returns with weights defined by the blue line in Chart A-1[35].

$$DEMA = \sum W(blue) * Daily\ Return$$

The blue line in Chart A-1 illustrates that the double exponential moving average places less emphasis on the current returns, the highest emphasis on the returns a few weeks or a few months ago and a decreasing emphasis on older returns.

Chart A-1. Weighting Functions, Exponential Averaging. Reference: theory.xls.

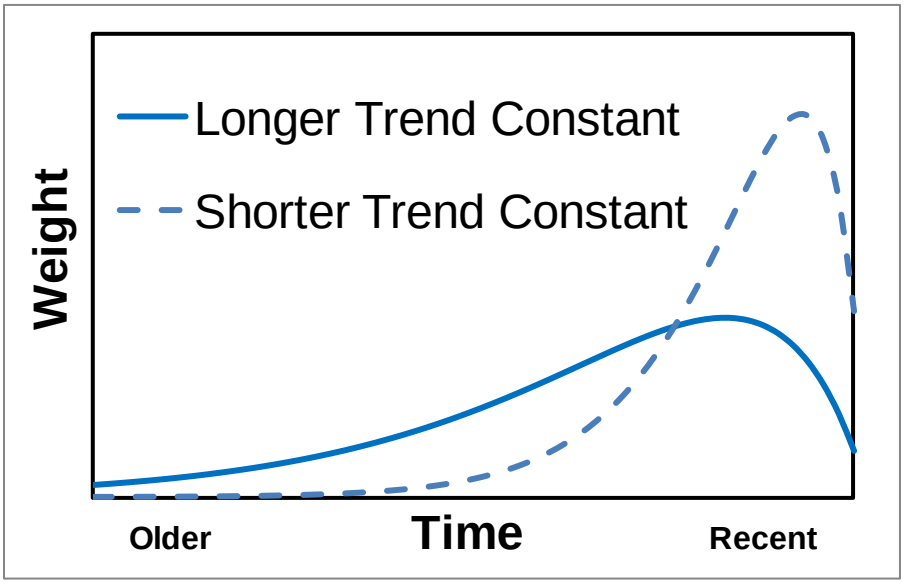


[35] This assumes that the smoothing factors are the same for both moving averages.

A parameter, which Juds calls the "trend constant," determines the time span over which the DEMA puts the most emphasis. A smaller value of the trend constant puts a greater emphasis on near term returns, as is illustrated in Chart A-2.

Juds' formulation of the DEMA algorithm differs from the usual formulations in that Juds defines the smoothing factor as the reciprocal of the trend constant.

Chart A-2. Effect of Trend Constant on DEMA Weighting. Reference: theory.xls.



Juds observed that the value of the trend constant affects the backtested investment performance. He introduced an optimization routine to periodically adjust the trend constant. Juds calls this process "forward walk progressive tuning" or FWPT.

The Monthly DEMA Approximation.

SectorSurfer® calculates double exponential moving averages from daily returns. The StormGuard® standard timing algorithm can be determined from December, 1950. Daily data for the S&P Composite without dividends are available from December, 1950 and the StormGuard® standard timing algorithm can be determined from 1952. (The delay is due to the time required for the algorithm to initialize.)

Daily mutual fund price data are not generally available before September 1988. Thus the SectorSurfer® daily DEMA allocation algorithm cannot be calculated before about 1990 for most funds.

Monthly data are available for foreign stock and REIT indices from the 1970s. A DEMA allocation algorithm based on monthly returns would allow additional years of backtesting of SectorSurfer®.

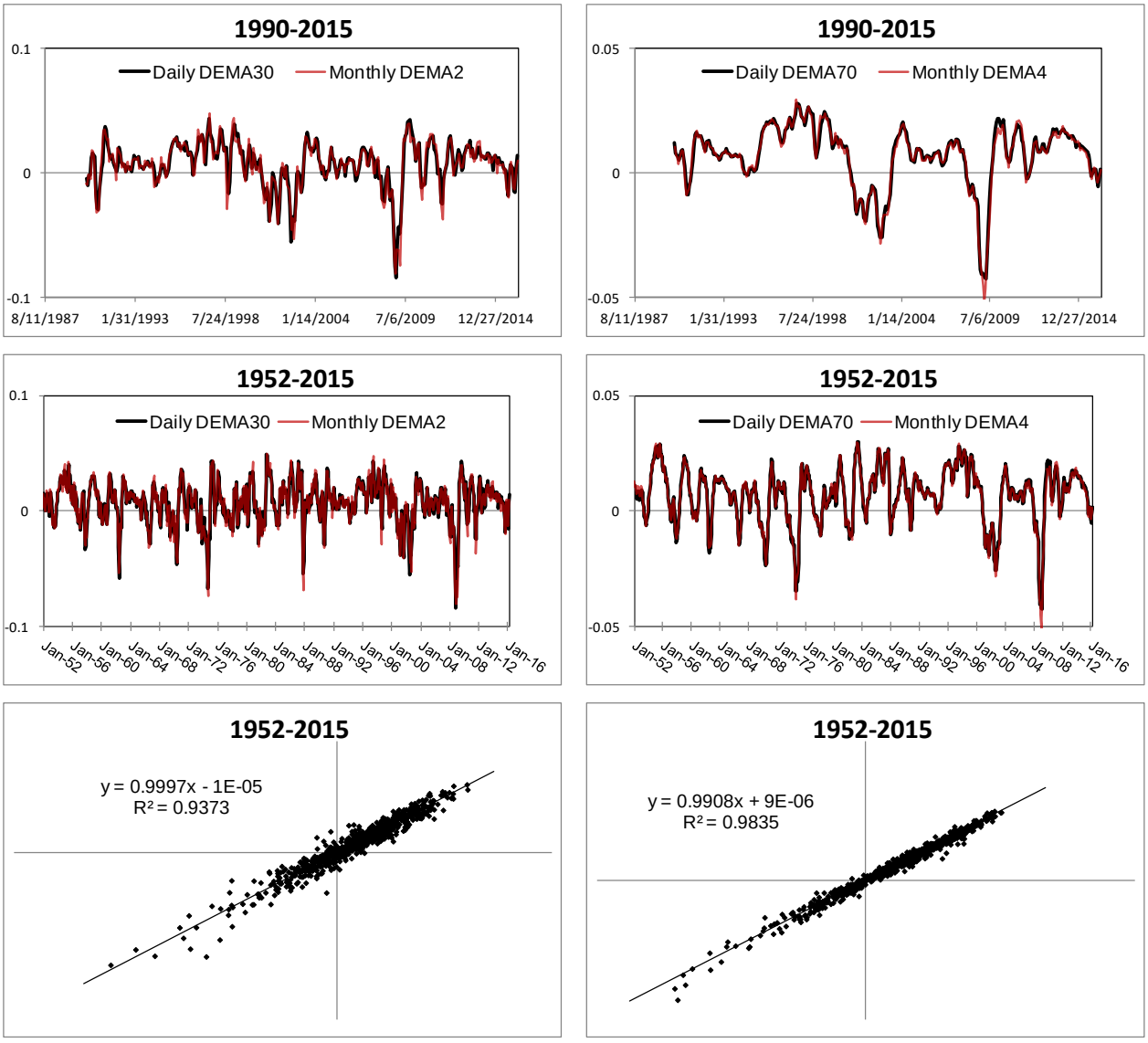
SectorSurfer® scales the daily returns in order to approximate monthly returns. Scaling is not needed when basing the allocation decision on monthly data.

Removing the scaling factor and reducing the trend constant produce DEMA trends based on monthly returns which approximate the DEMA trends from daily returns.

The monthly trend constant should be about equal to the daily trend constant reduced by a factor equal to the number of market days in a typical month. The reduction factors were chosen to maximize the value of R-squared of the difference between the two distributions. For example, a monthly constant of two months corresponds to a daily trend constant of thirty days.

Chart A-3. DEMA Based on Daily or Monthly Values. S&P Composite without dividends. The red curves nearly superimposes on the black curves.

The black points are the differences between the monthly and daily DEMAs.



Source: forecasting with monthly data.xlsb.

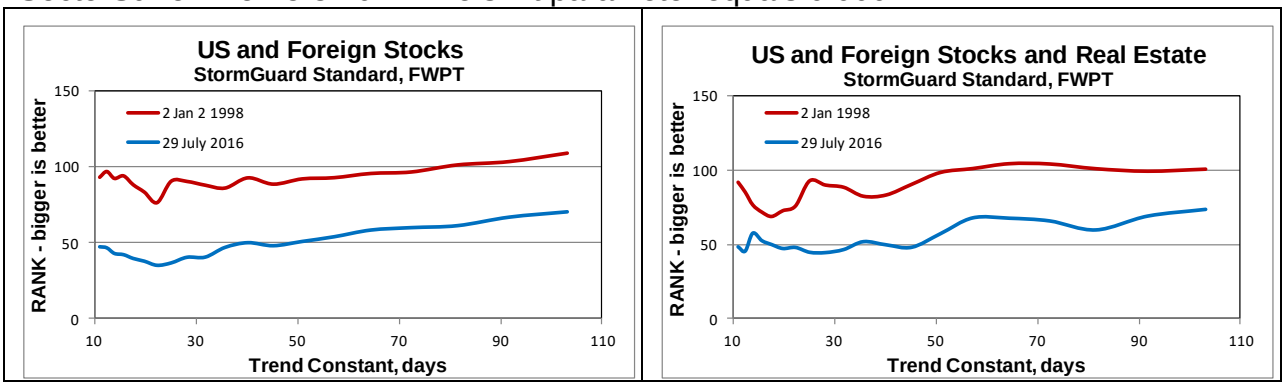
As shown in Chart A-3, DEMA trends calculated from monthly data using a trend constant of 2 months match the DEMA trends calculated from daily data using a trend constant of 30 days with an R-squared of 94%[36].

Trend constants of 4 months and 70 days provide similar DEMA trends with an R-squared of 98%. Rounding out the list, 3 months correlates with 50 days (R-squared 97%) and 5 months correlates with 90 days (R-squared 99%).

Knowing the relationship between the daily and monthly trend constants does not address the value of the trend constant needed for allocation decisions.

SectorSurfer® uses "tuning plots" to determine the value of the optimum value of the trend constant to be used in the allocation algorithm. The optimum trend constant is the value which maximizes RANK, a SectorSurfer® measure of return[37].

Chart A-4. SectorSurfer® Tuning Plots. FWPT adjusts the value of the trend constant at six month intervals to a value near the maximum in the tuning plot. US stocks are represented by VFINX, foreign stocks by HAINX and real estate by FRESX. SectorSurfer® ver. 5.3.201. The shift parameter equals 0.006.



Source: Monthly Allocations January 2017.xlsb. Workbook: SS.

Chart A-4 illustrates how RANK is affected by the value of the trend constant for the SIMPLE portfolio (left) and the SIMPLE portfolio plus real estate (right).

The tuning plots do not show pronounced maxima and are similar in 1998 and 2016. SectorSurfer sets the value of the trend constant equal to 103 days for the SIMPLE portfolio. The average value of the trend constant is 94 days for

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[36] The values of R-squared correspond to the trend constants quoted. Marginally better values of R-squared are possible if the daily trend constant is changed by a few days.

[37] SectorSurfer® ver. 5.0.85 defines RANK as the annualized return through the tuning date plus the annualized return over the 3 years ending on the tuning date divided by the sum of 0.4 + RiskofLoss.

RiskofLoss is defined as the average of the rolling 1-yr returns (losses only; gains are neglected) over the period prior to the retuning date.

RANK is defined differently at the initial tuning which is why the red curves lie above the blue curves.

RANK may be defined differently in later versions of the software.

the SIMPLE portfolio plus real estate. These values of the trend constant correspond to a monthly trend constant of about 5 months.

Table A-1 compares the statistics for SIMPLE portfolio managed using SectorSurfer® and the monthly approximation. DemaOpt and SectorSurfer® trade on the day after the signal date.

Table A-1. Statistics for US Stocks (VFINX) and Foreign Stocks (HAINX), 1990 - 2016. Month-end signals; trade next day. The table also shows the average allocation to US and foreign stocks and to bonds. SectorSurfer® ver. 5.3.201.

	US Stocks	Bonds	Foreign Stocks	CAGR	Sharpe	Max DD	Max DD Date
Buy and Hold	0.300	0.400	0.300	5.7	38	36	2/2009
DEMA(TC=4) & StormGuard Std	0.460	0.157	0.383	13.6	83	24	10/2008
DEMA(TC=5) & StormGuard Std	0.481	0.157	0.361	14.0	85	24	10/2008
DEMA(TC=6) & StormGuard Std	0.481	0.157	0.361	14.7	89	24	10/2008
DemaOpt, StormGuard Std	0.441	0.157	0.401	14.2	89	20	10/2008
SectorSurfer(FWPT) & StormGuard Std	0.495	0.154	0.351	14.9	91	23	10/2008

Source: Monthly Allocations January 2017.xlsb; Appendix3_DemaOpt.xlsb

The monthly DEMA approximation provides similar statistics and similar average allocations as compared to SectorSurfer®[38] when trading on the day after the signal date.

Table A-2 summarizes the statistics for the SIMPLE portfolio plus real estate.

I have included the statistics for Antonacci's 2-Step and "how to use it" implementations of Dual Momentum. While the differences between the 2-Step and "how to use it" implementations were small for the SIMPLE portfolio, they are significant when real estate is added to the mix.

[38] Performance statistics, including the maximum drawdown, were calculated by the author from month-end values drawn from the daily SectorSurfer®' equity curve.

Table A-2. Statistics for US Stocks (VFINX), Foreign Stocks (VGTSX) and Real Estate (FRESX), 1990 - 2016. SectorSurfer® statistics were calculated from the monthly equity curve. SectorSurfer® ver. 5.3.201.

Jul '97 - Apr '16	US Stocks	Bonds	Foreign Stocks	RE	CAGR	Sharpe	Max DD
24:24:12:40 Buy & Hold	0.240	0.400	0.240	0.120		44	38
Dual Momentum, 2-Step		0.252	0.164	0.376		63	21
Dual Momentum, How to Use It		0.097	0.173	0.522		74	21
DEMA(TC=4), StormGuard Std	0.241	0.157	0.207	0.395	15.2	92	24
DEMA(TC=5), StormGuard Std	0.265	0.157	0.182	0.395	14.6	89	24
DEMA(TC=6), StormGuard Std	0.281	0.157	0.188	0.373	13.9	83	24
DemaOpt, StormGuard Std	0.194	0.157	0.262	0.386	15.1	89	20
SectorSurfer(FWPT), StormGuard Std	0.245	0.154	0.182	0.419	16.3	97	23

Source: Monthly Allocations January 2017.xlsb; Appendix3_DemaOpt.xlsb

SectorSurfer® performs differently from the monthly DEMA approximation with the SIMPLE portfolio plus real estate. SectorSurfer® allocates more frequently to real estate and less frequently to foreign stocks. SectorSurfer® provides an extra hundred basis points of return, higher Sharpe ratio and slightly larger maximum drawdown.

Part of the difference is due to the fact that SectorSurfer® increased the value of the StormGuard® shift parameter from 0.006 to 0.007 for this portfolio[39]. This change had the effect of decreasing the average bond allocation. That is, the portfolio spends less time in cash when the shift equals 0.007.

However, the effect of the shift on the performance statistics is not large enough to explain the differences between SectorSurfer® and the monthly approximation.

TEST DEMA5; what trend constant is SS using?

[39] The value of the shift was 0.007 on May 7, 2016 for a portfolio of VFINX, VGTSX and FRESX and 0.006 on January 12, 2017 for a portfolio of VFINX, HAINX and FRESX.

The combination of StormGuard (shift = 0.006) and the monthly DEMA approximation with a trend constant of 4 months are referenced in this report as the "monthly SectorSurfer strategy."

The monthly SectorSurfer strategy is a reasonable approximation for SectorSurfer® in situations, as with the SIMPLE portfolio, where RANK is not sensitive to the trend constant.

Appendix B. The 28, 32 and 74-Fund Opportunity Sets

There are two systems for classifying US companies. The first is the Global Industry Classification Standard system. The GICS system is preferred by MSCI and Standard & Poor's. The second system is the Industry Classification Benchmark system. The ICB system is preferred by Dow Jones and FTSE. Both systems divide US companies into eleven primary categories; real estate was separated from the rest of the financial category in 2016.

There are data for the GICS categories back to at least 1970.

The eleven SPDR sector funds were developed by State Street Global Advisors based on the GICS classification system. Investments are limited to the companies in the S&P 500 Composite. There are price data for nine of these funds from December 1998.

The ten iShares Dow Jones Sector ETFs employ the ICB classification system. Investments are drawn from all of the companies in the Dow Jones US Index. These sector funds therefore include the stocks of smaller firms that are excluded from the SPDR sector funds. There is also an iShares US real estate fund. There are data for the iShares funds from mid 2002.

Vanguard has ten funds based on the ten GICS categories. Vanguard also offers a real estate index fund. The Vanguard funds are available as both mutual funds and ETFs. Data are generally from 2004.

Vanguard has three actively managed sector funds with long histories.

There are many actively managed Fidelity Select funds[40]. The Fidelity funds are more focused than the GICS or ICB categories and they often provide higher and more volatile returns. The frequent manager changes suggest that past performance vis-à-vis a sector could be different from future performance vis-à-vis the same sector.

The 32 funds shown in Table F-1 were obtained by eliminating the funds without data histories from September 1988, by eliminating the funds that invest in more than one category and by eliminating money market funds.

FSAVX was unwisely omitted because I considered it too volatile. A prima face example of selection bias!

GD-PM was included so as to be able to track the price of gold bullion over a longer period than is possible using GLD, an exchange traded fund which tracks the price of gold with history from 2004. The price of GLD steadily underperforms GD-PM by about the expense ratio of GLD, 0.4% annually.

The price history of GLD bears little relationship to the price history of FSAGX or VGPMX.

[40] There were 46 Fidelity Select funds 2014. This included FRXIX, which is a different share class of FSRVX the Dow Jones Real Estate Index fund. This total also included FSPFX and FNINX which have been discontinued.

Table B-1. The 32 Fund Universe. . The percentage figures indicate a fund's allocation to its sector; for example, FIDSX holds mostly financial stocks and about 5% technology stocks. Sector allocations are from Fidleity.com under the "Composition" tab and reflect allocations as of December 31, 2013 or thereabouts. Ticker symbols for the 19 funds used to construct the 10 of 19 portfolios are preceded by asterisks.

Ticker	Category[41]	Name or Description
*FBIOX	Healthcare 99%	Biotechnology
FBMPX	Discretionary 98%	Multimedia
*FDCPX	Technology 99%	Computers
*FDFAX	Staples 97%	Consumer Staples
*FDLSX	Discretionary 98%	Leisure
*FIDSX	Financial, 5% Tech	Financial Services
FRESX	Real Estate	Real Estate
*FSAGX	Precious Metals (Materials)	Gold stocks and gold bullion
*FSAIX	Industrial 93%	Air Transportation
FSCGX	Industrial, 3% Discretionary	Industrial Equipment
*FSCHX	Materials 97%	Chemicals
*FSCSX	Technology, 3% Discretionary	Software & Computer
*FSDAX	Industrial, 2% Materials	Defense & Aerospace
FSDPX	Materials, 2% Energy	Materials
*FSELX	Technology 95%	Electronics
*FSENX	Energy 96%	Energy
*FSESX	Energy 99%	Energy Services
FSHCX	Healthcare 95%	Medical Delivery
*FSLBX	Financial 97%	Brokerage & Investment Mgmt.
FSPCX	Financial 97%	Insurance
*FSPHX	Healthcare 96%	Healthcare
*FSPTX	Technology, 5% Discretionary	Technology
FSRBX	Financial, 2% Technology	Banking
FSRFX	Industrial, 2% Energy & Financial	Transportation
FSRPX	Discretionary, 4% Staples & Tech	Retailing
*FSTCX	Technology, 9% Financial	Telecommunications

[41] The IT and telecommunications categories have been combined. FSAGX and VGPMX invest in Precious Metals, a subsector of Materials. FSAGX has an allocation to gold bullion and VGMPX has a modest allocation to Industrials.

*FSUTX	Utilities, 19% Energy	Utilities
*FSVLX	Financial, 19% Technology	Consumer Finance
GD-PM	Precious Metals	Gold Price, London PM Fixing
VGENX	Energy	Energy
VGHCX	Healthcare	Healthcare
VGPMX	Precious Metals (89% Materials, 11% Industrials)	Mining and Exploration for Precious Metals

Experience with the 32 fund universe suggests that several funds could be eliminated.

- There is seldom allocation to a fund if the return is correlated to the return of a more volatile fund. For example, there is seldom allocation to the Vanguard funds because the Fidelity Select funds with similar objectives are more volatile.

  The less volatile fund could probably be eliminated without introducing selection bias but the simulator seems undeterred by the presence of less volatile funds.

- It is desirable to have all of the investment choices in the same mutual fund family because of the practical challenges in trading between fund families in accounts where margin in not an option.

What these observations mean for the 32-fund universe is that the Vanguard funds might be eliminated. The precious metal funds might be eliminated if you do not see yourself investing your entire portfolio in gold bullion.

Backtesting shows that there have been times when precious metals were important investment options.

The 28 fund universe is the 32-fund universe plus FSAVX and less the precious metal and Vanguard funds.

Less thought went into the construction of the 74 fund Global Opportunity Set. The primary purpose in creating this universe was to test how the simulator would perform with so many choices. It seemed to do just fine. Several country ETFs were omitted from the Global Opportunity set because of low trading volumes.

Table B-2. The 74 Fund Global Opportunity Set includes the funds in Table B-1plus the funds in Table B-2 and plus FSAVX.

Ticker	Name or Description	History
ECH	Chile	Nov 2007
EIDO	Indonesia	May 2010
EPHE	Philippines	Sep 2010
EPOL	Poland	May 2010
EPU	Peru	Jun 2009
ERUS	Russia	Nov 2010
EWA	Australia Index (iShr)	Mar 1996
EWC	Canada Index (iShr)	Mar 1996
EWD	Sweden Index (iShr)	Mar 1996
EWG	Germany Index (iShr)	Mar 1996
EWH	Hong Kong Index (iShr)	Mar 1996
EWI	Italy Index (iShr)	Mar 1996
EWJ	Japan Index (iShr)	Mar 1996
EWK	Belgium Index (iShr)	Mar 1996
EWL	Switzerland Index (iShr)	Mar 1996
EWM	Malaysia Index (iShr)	Mar 1996
EWN	Netherlands Index (iShr)	Mar 1996
EWO	Austria Index (iShr)	Mar 1996
EWP	Spain Index (iShr)	Mar 1996
EWQ	France Index \(iShr)	Mar 1996
EWS	Singapore Index (iShr)	Mar 1996
EWT	Taiwan (iShr)	Jun 2000
EWU	United Kingdom Index (iShr)	Mar 1996
EWW	Mexico Index (iShr)	Mar 1996
EWX	Emerging Markets Small Cap (SPDR)	May 2008
EWY	South Korea (iShr)	May 2000
EWZ	Brazil (iShr)	Jul 2000
EZA	South Africa	Feb 2003
FXI	China Large Cap (iShr)	Oct 2004

INDA	India (iShr)	Feb 2012
THD	Thailand	Mar 2008
TUR	Turkey	Mar 2008
FSAVX	Automotive	Sep 1988
FSCPX	Consumer Discretionary	Jun 1990
FSDCX	Communications Equipment	Jun 1990
VEIEX	US Extended Market	May 1994
VEURX	European Large Cap	Jun 1990
VEXMX	US Extended Market	Sep 1988
VGTSX	World ex-US	Apr 1996
VPACX	Pacific Large Cap	Jun 1990
VBMFX	Intermediate Term Bonds	Sep 1988
VUSTX	Long Term Treasury Bonds	Sep 1988

Appendix C. The Risk Index

The Siegel Timing Strategy

A 200dSMA timer compares the daily price of a "risk index" to the 200-day simple moving average (SMA) of the risk index. This appendix shows that the performance of the 200dSMA is influenced by whether signals occur daily or monthly and by the nature of the risk index.

Siegel made unfortunate choices with respect to both parameters[42].

Siegel bases his timer on the daily dividend adjusted prices of the Dow Jones Industrial Average (DJITR). In S&P's parlance, the DJITR is the "risk index."

Siegel's algorithm buys stocks when the price of DJITR is at least one percent above its 200dSMA and sells stocks when the price of DJITR is at least one percent below its 200dSMA.

Decisions are made daily. The comparison between price and 200dSMA is made at the close on the signal date and trades occur at the close on day after the signal date.

The purpose of the one percent tolerance is to reduce the risk of trading just before the market reverses direction. The round trip associated with premature trading often results in a "whipsaw" loss.

Siegel invests his cash position in Treasury Bills.

Siegel concludes

The buy-and-hold strategy from 2001 to 2012 beats the timing strategy by more than 2 percentage points per year even before transaction costs are factored in. ... Although the returns from the timing strategy often fall behind that of a buy-and-hold investor, the major gain from the timing strategy is that the timing investor is out of stocks before the bottom of every major bear market. Since the market timer is in the market less than two-thirds of the time, the standard deviation of returns is reduced by about one-quarter over the returns of a buy-and-hold investor. This means that on an annual risk-adjusted basis, the return on the 200-day moving-average strategy is still impressive, even when transaction costs are included[43].

The statistics in Table 1 confirm Siegel's observation that daily timing with the DJITR as the risk index reduces the return (bad) and reduces the standard deviation (good) over this interval as compared to the unmanaged portfolio.

Siegel was too quick to generalize from this observation. Table 1 also shows that making timing decisions at the end of the month, rather than daily, or

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[42] Jeremy J. Siegel, *Stocks for the Long Run*, McGraw-Hill, 5th Edition, 2013, Chapter 20 and Table 20-1.

[43] Jeremy J. Siegel, *op. cit.*, Chapter 20.

using the S&P 500 Composite without dividends as the risk index provides a higher return, a higher Sharpe Ratio and a lower drawdown than the unmanaged portfolio.

Table C-1. Timing the Dow Jones Industrial Average Total Return Index, 2001-2012. The first signal is on Dec. 29, 2000, annualized returns are measured as of Dec. 31, 2012, statistics are determined from the monthly equity curve, tolerances are 1% and cash is represented by FSLXX. The first two rows are from Siegel, Table 20-1.

When two entries are shown for a statistic, the first entry corresponds to trading on the signal data and the second corresponds to trading on the day after the signal date. The offset in trade date has no effect for monthly timing to within the precision shown.

	Risk Index	CAGR	Standard Deviation[44]	Sharpe Ratio[45]	Maximum Drawdown
DJITR, B&H		4.07	16.4	not reported	not reported
DJITR, daily timing	DJITR	1.33	12.3	not reported	not reported
DIA, B&H		4.06	15.0	22	47
DJITR, B&H		4.15	15.1	23	47
DIA, daily timing	DIA	2.45/2.18	9.9/10.1	11/9	42/42
DJITR, daily timing	DJITR	3.20/3.03	9.9/9.7	19/17	38/38
DJITR, daily timing	DJ-30	1.63/1.54	9.5/9.6	3/2	44/44
DJITR, daily timing	SP-CP	5.42/5.21	9.6/9.7	44/41	11/12
DIA, monthly timing	DIA	6.22	8.6	53	28
DJITR, monthly timing	DJITR	6.34	8.7	54	29
DJITR, monthly timing	DJ-30	5.11	8.3	43	24
DJITR, monthly timing	SP-CP	7.95	7.8	79	11
DJITR, monthly timing	VFINX	8.55	8.3	82	9
BNY-Mellon Benchmark	B&H	4.70	9.8	34	33

Source: DailyMarketTimer.xlsb

[44] SQRT(12) times the monthly standard deviation.

[45] SQRT(12) times the arithmetic average of the reduced monthly returns divided by the standard deviation of the reduced monthly returns. The reduced monthly return is the return in a specific month less the T-bill return for that month (Ibbotson SBBI data).

The Faber 10mSMA Indicator

Faber uses the S&P Composite with dividends reinvested as the risk index when calculating his timing indicator[46].

Faber's indicator signals a move to cash, or from cash, when the price of the S&P Composite with dividends reinvested is less than, or larger than or equal to, the 10-month simple moving average (10mSMA) of his risk index.

There is no tolerance band. Faber makes decisions and executes trades at the close on the last day of the month. He neglects transaction costs, as did Siegel, and invests his cash position in 90-day Treasury Bills.

Table C-2. Timing the Dow Jones Industrial Average Total Return Index Using Faber's 10MOM Algorithm, 2001-2012. Statistics are from the monthly equity curves, the tolerances are zero, trades are on signal date, and cash is represented by FSLXX.

	Risk Index	CAGR, %	Standard Deviation	Sharpe Ratio	Maximum Drawdown
DJITR, B&H		4.15	15.1	23	47
DJITR, monthly timing	VFINX	7.80	8.3	73	14
DJITR, monthly timing	SP-CP	8.26	8.2	79	11
DJITR, monthly timing	DJITR	5.95	8.8	50	29
BNY-Mellon Benchmark	B&H	4.70	9.8	34	33

Source: DailyMarketTimer.xlsb

Faber's 10mSMA bests the BNY-Mellon benchmark in terms of CAGR for all three risk indices and bests the benchmark in terms of drawdown for the S&P Composite, with or without dividends, as the risk index.

The final table in this appendix illustrates the effects of risk index for several algorithms. It can be seen that

- No algorithm is more effective with DJITR as the risk index.
- Differences between the S&P 500 Composite with and without dividends are small
- Using a bond fund to represent cash rather than a money market fund increases the return.

The 10-month MOM algorithm provides a lower drawdown than the Absolute Momentum algorithm over this interval.

[46] Mebane T. Faber "A Quantitative Approach to Tactical Asset Allocation." Working Paper May 2006, (the most recent revision is 2014) and *The Journal of Wealth Management*, Spring 2007.

Table C-3. Effects of Risk Index and Cash Representation, 1990 – June 2016. The algorithms are allocating between DJITR and cash using month-end signals. Tolerances are zero except where indicated. The trade date has no effect within the precision shown. SP-CP is the S&P Composite without dividends and Vanguard's Index 500 (VFINX) represents the S&P Composite with dividends.

	SP-CP and FSLXX			SP-CP and VBMFX			VFINX and VBMFX			DJITR and VBMFX		
	CAGR	Sharpe	MaxDD	CAGR	Sharpe	MaxDD	CAGR	Sharpe	MaxDD	CAGR	Sharpe	MaxDD
200dSMA (1%)	9.1	63	16	10.8	77	16	10.9	76	16	9.3	61	23
200dSMA	9.8	68	16	11.3	80	16	11.5	82	16	9.3	61	27
10mSMA	9.6	66	16	11.1	78	16	10.7	73	16	9.5	62	23
FundX	9.8	66	16	10.9	75	16	10.6	72	16	10.2	67	19
10MOM[47]	10.2	68	17	11.6	79	16	12.0	83	16	11.4	76	16
Absolute Momentum	10.9	71	17	11.7	76	21	11.7	75	20	9.6	57	31
DEMA50 (0.006)	10.9	71	17	11.7	76	21	11.7	75	20	9.6	57	31
Golden Cross[48]	9.5	64	16	10.7	74	16	11.3	77	16	9.2	58	28
SPVOL[49]	9.5	61	25	10.2	66	23	10.2	66	23	10.0	63	25

Source: DailyMarketTimer.xlsb

[47] The 10MOM indicator is bullish if the total return of the risk index is positive over ten months. The signal is bearish if the total return is negative.

[48] Golden Cross signals occur when the 50-day SMA of the daily price of the risk index crosses the 200-day SMA of the daily price of the risk index. The signal is bearish if 50SMA is declining at the crossover and bullish if 50SMA is rising at the crossover.

[49] Standard & Poors Dynamic Rebalancing Risk Control Indicator with a target volatility of 15% and no leverage. See Limiting Risk Exposure with S&P Risk Control Indices, February 2012; S&P Indices: Index Mathematics Methodology, January 2012; and S&P Risk Control Indices: Parameters, 5 January 2012.