Description of Timing and Allocation Algorithms

Updated October 14, 2019

The descriptions of the indicators are grouped by the type of information that the indicators measure. Signals are generally measured on the last day of the month with trades occurring at the close on the last day of the month.

Algorithms Which Measure the Price Trend. These indicators measure the value, or the rate of change in the value, of a risk index and allocate to stocks when the indicator is larger than a tolerance, allocate to cash or bonds when the indicator is less than a negative tolerance and leave the allocation unchanged when the indicator lies between the negative and positive tolerances.

The risk index is generally the price of large cap US stocks, with or without adjustment for dividends. Since there are monthly data for the dividend adjusted price of large cap US stocks from 1926, dividend adjusted data are generally used for indicators which are based on monthly data.

The dividend adjusted price of large cap US stocks is represented by the SBBI monthly dataset through 1997 and by the curated daily data thereafter.

The unadjusted price of large cap US stocks from 1950 is represented by the S&P Composite Index (Yahoo ^GSPC). Unadjusted prices of large cap US stocks are generally used for those indicators which require daily data.

For testing purposes, the eighteen or so timers which use month-end prices were also evaluated using the following risk indices:

LrgCapUS stocks with dividends (curated VFINX, from 1980)

S&P Composite without dividends (Yahoo ^GSPC, from 1950)

Mid cap US stocks (S&P 400) with dividends (curated PESPX, from mid-1991)

Small cap US stocks (Russell 2000) with dividends (curated NAESX from 1985 through 2000 and curated IWM thereafter)

Real estate with dividends (curated VGSIX, from mid-1996).

xMOM measures the dividend adjusted return of large cap US stocks over x months. The signal is bullish if xMOM is positive unless other tolerances are specified.

12AbsMom. Antonacci's Absolute Momentum algorithm is bullish if 12MOM of US large cap stocks *including dividends* is higher than 12MOM of Treasury Bills[1].

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

The return of Treasury bills is generally represented by the monthly SBBI/French data through 1997 and by the curated data for 4-week bills thereafter. See Appendix C.

The following table illustrates that better results are obtained using large cap stocks with dividends as the risk index. Conditions are as Table 3.

These results should be updated to use curated data.

AbsMom	11.99	0.84	16, Sep-11	83	0.6
AbsMom w/o dividends	10.57	0.78	18, May-12	68	1.4

5AbsMom is Don Maurer's quicker to respond version of AbsMom[2]. As used here, the signal is bullish if 5MOM of US large cap stocks *including dividends* is larger than 5MOM of 4-week Treasury Bills.

Mauer has implemented his timer as the return of US large cap stocks including dividends over the trialing 105 days less 5/12 times ^IRX, the annualized yield of 13-week Treasury bills. Mauer's implementation cannot be evaluated before about 1985 when daily dividend adjusted data for US large cap stocks become available.

AbsMom5_1 was proposed by Don Maurer, 2017?. The composite signal is bullish if absolute momentum over the trailing 1 **or** trailing five months is greater than or equal to zero.

AbsMomFx. This timer retains the concept of absolute momentum, the difference in the momentum of large cap US stocks and T-bills, while changing the momentum algorithm from 12mMOM to the FundX (1-1-1-1) algorithm. Proposed by Don Maurer, 2019.

xdSMA or xmSMA. The simple moving average of the daily price of the risk index over x days or over x months.

Siegel calculates the 200-day SMA of the Dow Jones 30 Industrials with dividends reinvested[3]. The signal is bullish if the price is more than 1% higher than the 200dSMA and bearish if the price is less than 99% of the 200dSMA. Trades can occur daily rather than only at month's end.

200dSMA as implemented here generates monthly signals calculated from the S&P Composite without dividends using zero tolerances. These changes improve the performance of the indicator.

[2] Don Maurer, "An Approach to Testing Price Based Timers," Silicon Valley CIMI Group, March 3, 2016.

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

Faber calculates the 10-month SMA of the S&P Composite with dividends reinvested and no tolerances [4]. Faber's signal is bullish if the price is higher than the value of the moving average,

The 10mSMA used here is the same as Faber's implementation. The 10mSMA indicator performs slightly better when dividends are omitted. CITE NEEDED

SMAG (5-10) and SMAG (6-9). These composite indicators were proposed by Don Maurer, 2019, and measure the average signal of the 5mSMA through 10mSMA indicators or the average signal of the 6mSMA through 9mSMA indicators.

Multi-Index, proposed by Don Maurer, 2019. The signal is the minimum of the signals for 10mSMA of large cap US stocks, 10mSMA of mid cap US stocks and 10mSMA of small cap US stocks.

Curated data for VFINX, PESPX and NAESX/IWM are used to represent the three asset classes. The signal can be determined from June 1992.

There are other components of this timer class. For example, the signal could be determined as the average of the three signals or the signals could be generated using a different algorithm such as DEMA50 or SWAG.

xEMA. Exponential moving average of the daily price of the risk index. The signal is bullish if the price of the risk index is higher than xEMA.

The usual definition of the coefficient alpha is 2 / (1 + x) and that is the definition used with the xEMA algorithm. Since Scott Juds uses an alternate definition of alpha, the definition of alpha is included with each algorithm.

EMAG (6-9). This composite indicator was proposed by Don Maurer, 2019. It measures the average signal of the 6mEMA through 9mEMA indicators.

EMA Golden Cross. EMA50 of the daily price of the S&P Composite *without dividends* crossing the EMA200 of the daily price. The indicator is bearish if EMA50 is declining at the crossover and bullish if EMA50 is rising at the crossover. As implemented here, the signal is bullish if EMA50 is greater than or equal to EMA200. Alpha = 2/(1 + x).

GOOD, "Get Out of Dodge" – This indicator is attributed to Don Gimpel[5]. Enter the market when the 50-day EMA of the risk index rises above the

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[4] Mebane T. Faber "A Quantitative Approach to Tactical Asset Allocation." Working Paper 2014 and *The Journal of Wealth Management*, Spring 2007. Faber found "equity-like returns with bond-like volatility and drawdown." See also Journal of Portfolio Management 2018.

We have confirmed the results of both Siegel and Faber and identified why their timing systems produce different results even though they average over similar time frames. The first reason is that Siegel makes timing decisions daily whereas Faber makes decisions monthly.

The second reason is that 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.

200EMA and exit the market when the 75EMA of the risk index falls below the 300EMA. Alpha = 2 / (1 + x). Signals are generally determined without tolerances.

Gimpel based his indicator on the daily values of SPY as is a proxy for the S&P Composite with dividends.

As implemented here, the GOOD indicator is based on the daily prices of the S&P 500 Composite without dividends since using unadjusted prices allows the indicator to be extended to 1951.

The following table illustrates that performance is not substantially affected by whether the risk index includes dividends. Conditions are as Table ?????.

GOOD	11.53	0.80	16, Nov-11	86	0.4
GOOD with dividends	10.46	0.79	16, Nov-11	86	0.5

MiniDipper. Bullish if 40dSMA of the unadjusted price of the S&P Composite is greater than the 170dSMA. Alpha = 2 / (1 + x). Developed by Jean-Marc Patenaude using SPY over the interval 1999 through February 2013[6]. Implemented here using the S&P 500 Composite *without dividends*.

FundX Family of Timing Algorithms

FundX Investment Management has used an algorithm called "SCORE" since the 1970s to rank funds by their momentum potential. FundX Investment Management does not use a timing algorithm. The FundX SCORE is the weighted sum of the 1-, 3-, 6- and 12-month total returns, plus additional items.

The FundX algorithm has spawned several timers based on different weighting schemes[7]. The risk index is usually the S&P 500 Composite *with dividends*. The indicators can be evaluated from 1927 and are bullish if the indicator is zero or positive. Weighting factors are summarized below.

	1-month Return	**3-month Return**	**6-month Return**	**9-month Return**	**12-month Return**
Accelerated Dual Momentum	1	1	1		
Nicholas[8]	1	1	1		1
OOPS[9]	2	1	1		1

[5] Don Gimbel, "Note 115: An Absolute Take-Out Signal," October 2013. As reported at www.aaiilosangeles.org/sumgrowth.htm.

[6] Jean-Marc Patenaude, "MiniDipper ETF Strategy," AAII Silicon Valley CIMI Group, March 12, 2013.

[7] Ren Curry, "Weights for 1.3.6.12 Momenta", AAII Silicon Valley CIMI Group, May 2, 2019. Curry identified the accelerated dual momentum, optimized CAGR, SWAG and VAA variants.

[8] John B. Nicholas, "Market Timers Yet Again," AAII Silicon Valley CIMI Group, August 10, 2015.

Optimized CAGR	50	10	35		5
SWAG	1	2	2		
VAA[10]	12	4	2		1
AAII VMQ[11]					
Faber[12]	1	1	1	1	1
12MOM					1

Golden Cross - 50-day SMA of the daily price of the S&P Composite without dividends crossing the 200-day SMA. The signal is bearish if 50dSMA is declining at the crossover and bullish if 50dSMA is rising at the crossover.

As implemented here, the signal is bullish when the value of the 50-day SMA lies above the 200-day SMA by more than a tolerance and bearish when the value lies below the 200-day SMA by a negative tolerance. The allocation is unchanged when the value lives within the tolerances. Tolerances are zero unless specified otherwise.

StormGuard® Standard – Double exponential moving average of the daily return of the risk index, alpha = 1/50. The signal is bullish if 22*DEMA50 is more than the shift parameter.

SectorSurfer® adjusts the value of the shift parameter for each portfolio composition using an unknown algorithm. A constant shift of 0.006 is used in the published historical values of StormGuard® standard[13]. The present implementation uses a constant value of 0.006 for the shift.

Modified StormGuard® - StormGuard® standard was optimized for the post-1988 interval. A larger value of alpha and a smaller value of the shift parameter improve returns, Sharpe ratios and drawdowns over both the 1952-

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[9] Ren Curry, personal communication, July 18, 2019. The timer's title is the result of Ren's misinterpreting the description of the VMQ algorithm.

[10] Wouter J. Keller and Jan Willem Keuning, "Breadth Momentum and Vigilant Asset Allocation (VAA); Winning More by Losing Less", July 14, 2017, SSRB-id3002624. This indicator is roughly equivalent to an equal weighting of the *annualized* returns over the 1-, 3-, 6- and 12-month intervals.

[11] Ren Curry, personal communication, Sept. 12, 2019. The indicator is the weighted average of the four prior quarterly returns of the security. Weights are 4, 2, 2 and 2. See www.aaii.com/investor-update/article/How-the-VMQ-Stocks-Momentum-Indicator-Was-Changed.

AAII developed this indicator to rank individual stocks. It is an allocation algorithm, not a timing algorithm.

CIMI evaluates the indicator at the end of each month whereas AAII only evaluates the indicator at the end of each calendar quarter.

Assuming that returns are additive, which is an approximation, VMQ translates into the weighted average of the 1-, 3-, 6- and 12-months returns with weights of 0, 1, 0, and 1.

[12] Mebane T. Faber, "Relative Strength Strategies for Investing," April 2010, SSRN-id1585517.

[13] www.sumgrowth.com.

1973 and 1974-2016 intervals, but at the expense of additional trading. See Table A-1. The modified StormGuard® timer used in this report is based on alpha = 1/35 and a constant shift of 0.003.

Table A-1. Effect of Shift and Trend Constant When Timing US large Cap Stocks. Signals and trades occur at month-end.

TC/Shift	CAGR 1952-1973	Sharpe 1952-1973	MaxDD 1952-1973	CAGR 1974-2016	Sharpe 1974-2016	MaxDD 1974-2016	Trades 1952-2016
50/0.006	9.6	59	19	12.7	65	30	54
45/0.006	10.0	62	18	12.9	66	30	54
40/0.004	10.5	68	17	13.0	69	23	70
35/0.003	10.9	72	16	13.0	69	23	80
30/0.002	10.7	71	16	12.3	64	23	106

The modified StormGuard® indicator responds more rapidly and provides better returns than the standard StormGuard® indicator before about 1995. See Figure A-1 and Table A-2.

Figure A-1. Relative Strength of Portfolios of Large Cap US Stocks Managed Using the Modified and Standard StormGuard® Indicators, 1951-2018.

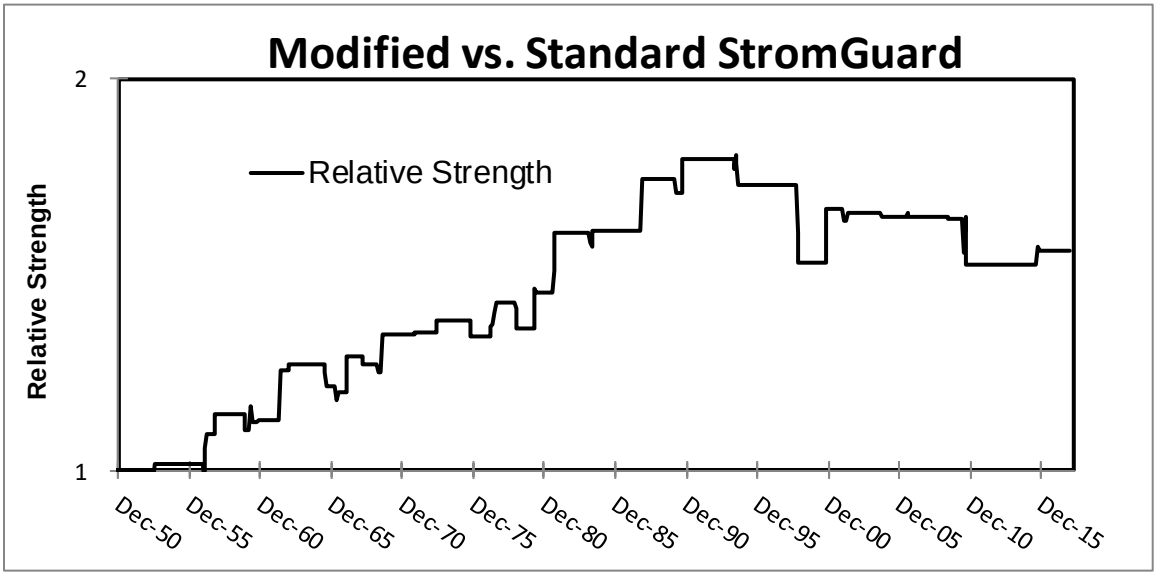

Table A-2. Performance Statistics, 1951 – 2018. Managed portfolios contain large cap US stocks or bonds; reference portfolio contains 60% stocks and 40% bonds. Not curated data.

12/31/1950 – 4/30/2018	CAGR, %	Sharpe	MaxDD, %	Win Ratio, %	Trades/yr
Unmanaged					
60:40 reference portfolio	9.24	0.57	17, Nov-87 33, Feb-09	Reference	1.0
US Large Cap Stocks	10.98	0.51	30, Nov-87 51, Feb-09	70	0.0
Price Trend Indicators					
Absolute Momentum	11.73	0.68	14, Oct-08 30, Oct-87	70	0.8
StormGuard® Std	11.86	0.66	21, Oct-08 30, Oct-87	74	0.8
Modified StormGuard	12.51	0.73	21, Oct-08 23, Oct-87	81	1.2
5AbsMom	12.58	0.77	13, Oct-08 23, Oct-87	75	1.6
AbsMom + 5AbsMom Composite	12.22	0.76	13, Oct-08 26, Nov-87	79	2.3

Bullish Percent indices exist for several markets and ETFs. They indicate the number of securities with Point and Figure buy signals. Entry and exit points are determined as the crossover of two moving exponential averages[14].

Indicators Based on Price and Volume ("Momentum")

DR*VOL - DEMA50 of the product of the daily return of the S&P Composite without dividends times the daily volume, divided by DEMA50 of the daily volume of the Composite[15]. Alpha = 1/50. The signal is bullish if the indicator is positive. Alternate values of alpha have not been tested.

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[14]stockcharts.com/school/doku.php?st=bullish+percent+index&id=chart_school:technical_indicators:bullish_percent_index

[15] Gregory Morris, *The Complete Guide to Market Breadth Indicators: How to Analyze and Evaluate Market Direction and Strength* describes algorithms of this type. The specific form of this algorithm was suggested by John Nicholas and Don Maurer in April 2016. The division by DEMA50 of the daily volume is unnecessary since the division does not affect the signal dates.

The source of the daily volume published by Yahoo is unknown; it is not sourced from S&P (e-mail from Haillet Rivero of S&P Dow Jones Indices, October 1, 2019.) It may represent the sum of the weighted volumes of the S&P 500 components.

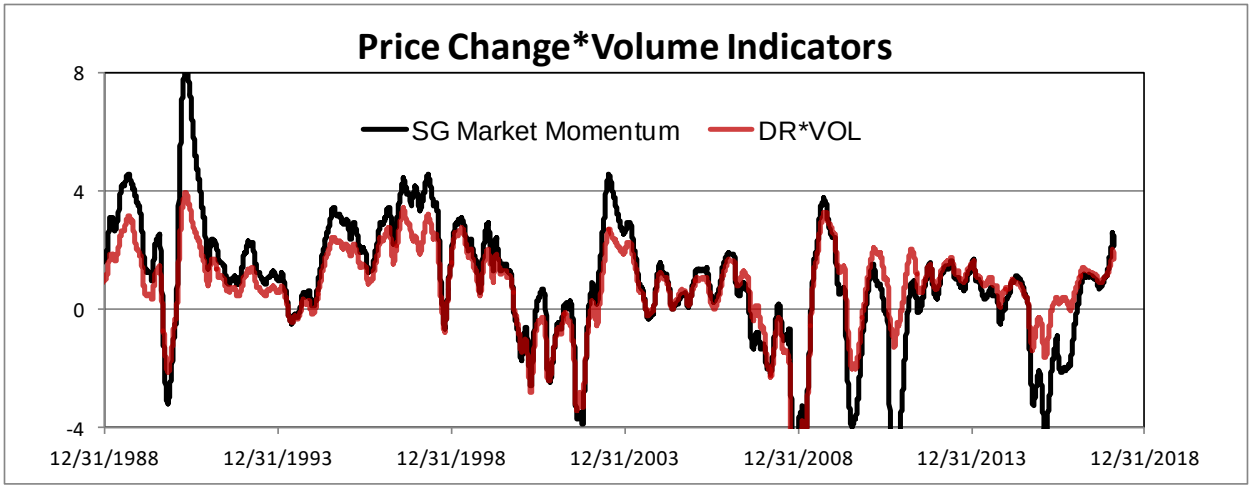
Ren Curry has observed that normalization by DEMA50 of the daily volume is unnecessary because normalization has no effect on the signals[16].

DR*PR*VOL - DEMA50 of Daily Return*Daily Price*Daily Volume divided by DEMA50 of Daily Price*Daily Volume. Created by Don Maurer, 2019.

Month-end signals of the DR*VOL and DR*PR*VOL algorithms differ in seven of 606 months (1968 – June 2019).

SectorSurfer® Market Momentum. Juds defines his Market Momentum indicator at sumgrowth.com as the "double EMA 50-day of daily returns, modified by relative daily volume." He described the indicator as the product of volume and return in a 2016 seminar. The time trace of Juds' indicator is similar to the time trace of the DR*VOL[17].

Figure A-2.



As shown in the table of performance statistics earlier in this report, the DR*VOL indicator provides a higher annualized return than the StormGuard® Momentum indicator, a higher Sharpe ratio and lower drawdown.

Algorithms Based on Volatility

SPVOL - Standard & Poors' Dynamic Rebalancing Risk Control Indicator[18] determines the equity allocation as a target volatility divided by the current volatility of a risk index. As implemented here, the risk index is S&P Composite without dividends, the target volatility is 18% annually and the equity allocation is capped at 100%.

The annualized current volatility is defined as the square root of

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[16] Ren Curry, e-mail to Don Maurer with copies to Peter Lingane and Simon Lee, June 19, 2019.

[17] The values of DR*VOL have been scaled up two-fold in this chart.

[18] 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.

252 * EMA of { ln(1+DailyReturn)^2 }.

The EMA trend constant is either 0.03 or 0.06. The annualized current volatility is the larger of the square rooted values.

The SPVOL calculation is illustrated in the spreadsheet "curated data," workbook "SPVOL."

VOL63d. Also known as Macquarie. Implemented as the standard deviation of sixty-three trailing daily returns of the S&P500 composite index without dividends (^GSPC.) This version of the timer can be evaluated from mid-1950.

Don Maurer implements this timer using SPY (Yahoo), which limits the interval over which his implementation can be evaluated.

Risk Parity – add description

Indicators Which Measure Market Sentiment

NASDAQ Hi-Lo[19]. This daily indicator is the cumulative difference between the number of new highs and the number of new lows recorded on the NASDAQ exchange. Cumulative differences are measured from September 1, 1988.

As implemented here, the indicator is bullish when the cumulative difference lies on or above the 8-day exponential moving average. Tolerances are zero.

Table A-2 shows that performance is similar over a range of the parameters. Alpha = 1/8 was chosen based on the Sharpe ratio.

Table A-3. Performance of the NASDAQ HiLo Indicator, 1990 - June 2016. Allocation is between cash or a portfolio of 40% VFINX, 40% HAINX and 20% FRESX. The shaded parameters correspond to the *Patient Fisherman* blog[20].

	CAGR, %	Sharpe	MaxDD, %	Trade Frequency
40:40:20:00	9.95	52	56	Monthly
Unsmoothed vs. 4EMA	12.05	98	10.1	3.0 per year
2SMA vs. 4EMA	11.71	95	10.1	3.1
Unsmoothed vs. 5EMA	12.14	98	10.1	2.9
2SMA vs. 5EMA	11.99	97	10.1	2.9
Unsmoothed vs. 6EMA	11.90	96	10.6	2.8
2SMA vs. 6EMA	11.96	96	10.6	2.8
Unsmoothed vs. 7EMA	11.97	97	10.6	2.8
2SMA vs. 7EMA	12.22	99	10.6	2.8

[19] Developed by Al Zmyslowski in xxxx based on an entry in The Patient Fisherman blog.

[20] The blog employed a 1-day moving average (that is, unsmoothed data) crossing 10EMA over the interval 2009-2011. 10EMA corresponds to alpha = 2/(10+1) or to a 5½ day time constant in the notation used here.

Unsmoothed vs. 8EMA	12.53	102	10.6	2.5
2SMA vs. 8EMA	12.15	97	11.1	2.7
Unsmoothed vs. 9EMA	12.17	98	10.3	2.5
2SMA vs. 9EMA	11.95	95	11.1	2.6
Unsmoothed vs. 10EMA	11.67	92	11.1	2.5
2SMA vs. 10EMA	10.98	87	11.1	2.6

Source: DailyMarketTimer.xlsb.

Synthetic MSI. The synthetic Market Sentiment Index (MSI) indicator measures the fraction of stocks whose prices are above their individual 75dSMA. The universe is US stocks with 20-day average liquidities of at least $500,000. Signals are generated when the 5dEMA of the measured fractions crosses zero. Signals are available daily.

Delta Investment Management's MSI indicator measures the fraction of larger US stocks whose prices are above their 75-day simple moving averages. The value of the indicator is published in Barron's[21].

The Delta indicator is apparently adapted from the INSTITECH© technical analysis system developed by Howard Hebert about 1972. The Hebert indicator measures the fraction of a broad US stock universe whose prices are above their 13-week SMAs.

Delta allocates the tactical portion of the portfolio to stocks when the indicator exceeds 53% and to cash when the indicator is less than 47%. A proprietary algorithm makes the call when the fraction of stocks lies between these limits.

In devising signals based on the Delta data, I allocated to stocks when the indicator value was equal to or larger than 53%, allocated to intermediate term bonds when the indicator value was equal to or less than 47% and left the allocation unchanged when the indicator value lay between these limits.

The Delta MSI indicator signals are only available weekly, and the history is limited. Don Maurer, Al Zmyslowski and I therefore undertook to synthesize an MSI indicator which could be evaluated daily over a longer history.

Table A-4. Accuracy of Synthetic MSI indicators and Correlation to the Delta MSI. Fractions above their 75dSMA were determined using Portolio123.

A trend constant of 1 market day provides no smoothing.

TC =	**1**	**2**	**4**	**5**	**6**	**8**	**10**
Signal Accuracy, % same							
S&P500 Composite	88	89	91	91	91	90	91
S&P1500 Composite	77	76	78	79	79	79	81

[21] www.barrons.com/public/page/delta-tactical.html.

Russell 3000	85	86	89	89	91	92	91
Russell 2000	82	83	84	85	84	83	84
Liquidity > $500K	89	91	93	95	93	92	91
Liquidity > $750K	89	91	94	95	93	93	92
Liquidity > $1 million	90	91	94	95	93	93	92
Liquidity > $10 million	91	90	93	93	92	92	92
Correlation, %							
S&P500 Composite	87	89	90	89	88	86	84
S&P1500 Composite	70	71	72	72	72	71	70
Russell 3000	93	96	96	96	95	93	91
Russell 2000	89	92	93	92	91	90	88
Liquidity > $500K	95	97	97	96	95	93	91
Liquidity > $750K	95	97	97	96	96	93	91
Liquidity > $1 million	95	97	97	97	96	93	91
Liquidity > $10 million	94	96	96	95	95	92	90

Source: Analysis MSI.xlsb

We measured the daily fraction of stocks with prices above their respective 75-day simple moving averages for the following US stock universes.

- S&P500 Composite (large cap UIS stocks)
- S&P1500 Composite (90% of the total US stock market).
- Russell 3000 index, another measure of the total US stock market.
- Russell 2000 Index, a measure of smaller US stocks.
- US stocks with daily liquidity, averaged over twenty market days, exceeding a threshold.

The daily fractions were smoothed using a N period exponential moving average. Signals were bullish when the smoothed value of the indicator equaled or exceeded 50%.

Table A-3 shows the accuracy of the weekly signals as a function of the smoothing applied to the synthesized values[22]. There were 257 comparisons from June 6, 2013 through May 3, 2018.

The table also shows the correlations between the weekly signals of the Delta and synthetic indicators.

A smoothing constant of about 4 market days provides the highest correlations between the DELTA MSI indicator and the synthetic indicators and a

[22] Following SectorSurfer®, the smoothing coefficients are defined as 1/N and (N-1)/N.

smoothing constant of about 5 days provides the highest signal accuracy. A smoothing constant of 5 market days is used in the balance of this report.

Using fixed liquidity criteria, as done here, means that the criteria do not scale well over time. It would be better to rank the stocks in terms of liquidity and to set the criteria in terms of liquidity rank.

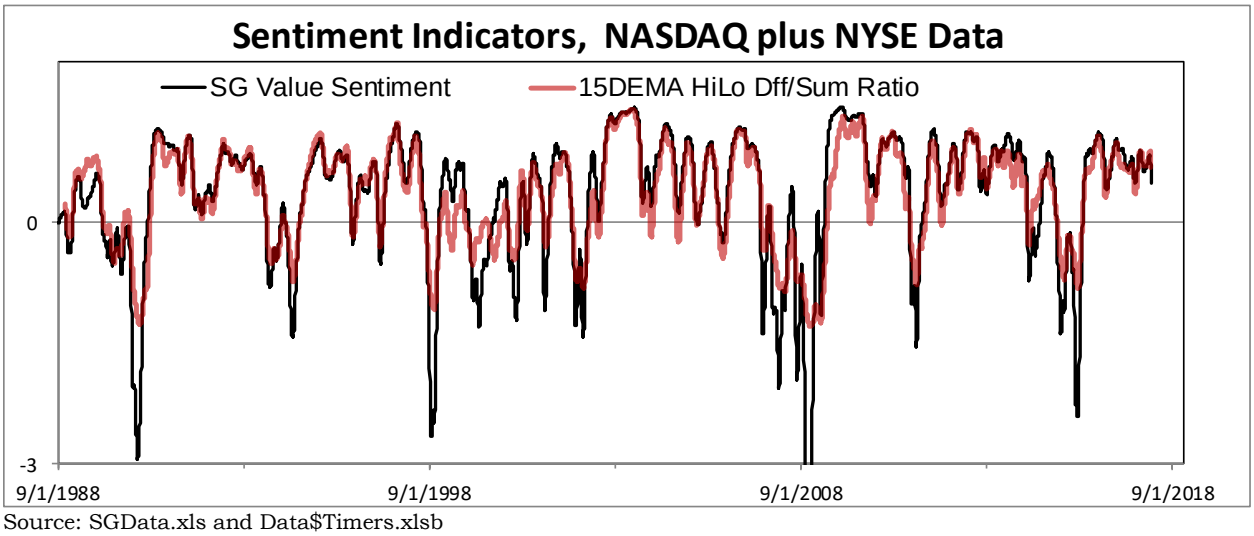
Since the DELTA universe currently contains about two thousand stocks and since there are nearly ten thousand stocks in the Portfolio123 Total US Stock universe, the ranked cut would be on the order or 20% of the total stocks. If we were to emphasize mid-cap stocks, the criteria might be a liquidity rank of more than seventy percent and less than ninety percent.

Dorsey Wright PTNYSE measures the fraction of NYSE stocks with positive trends. A value greater than fifty percent is bullish. Data are available from ??

StormGuard® Value Sentiment Indicator. Juds describes this indicator as the "DEMA15 of ratio adjusted new highs and new lows" as reported on the NYSE and the NASDAQ exchanges.

The Total High Low Difference Sum indicator ("THiLoDifSum") is DEMA15 of the daily difference between the total new highs and total new lows recorded on the NASDAQ and NYSE exchanges divided by the daily sum of the total new highs and new lows. This indicator generally provides a good visual match to the Sentiment indicator[23]. Ninety-one percent of the post-1989 daily signals are the same.

Figure A-3.



Source: SGData.xls and Data$Timers.xlsb

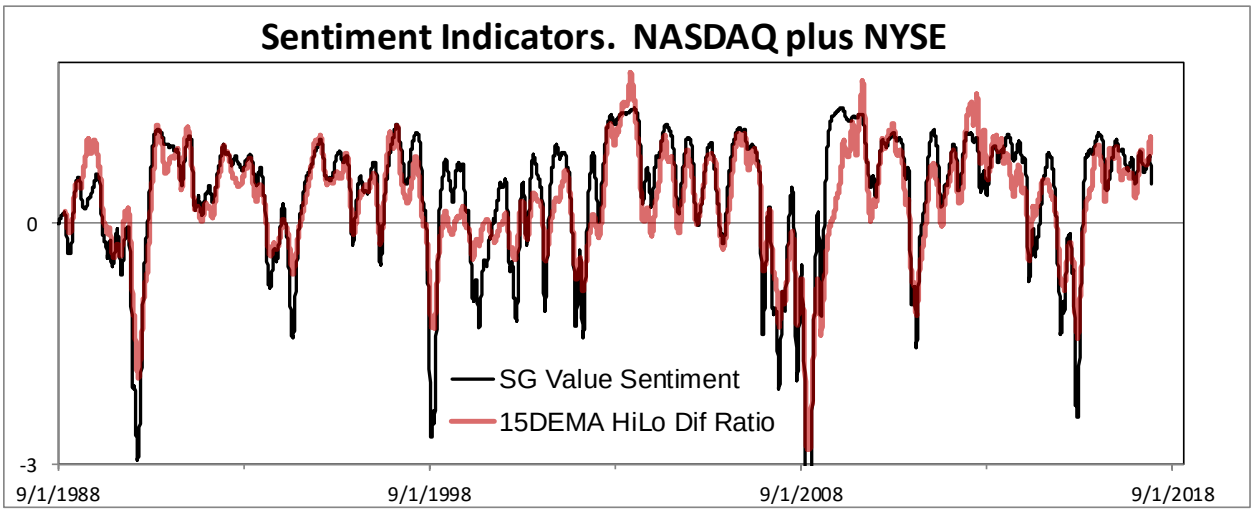
The Total High Low Difference Ratio indicator ("THiLoDifRatio") is DEMA15 of the daily difference between the total new highs and total new lows recorded on the NASDAQ and NYSE exchanges divided by the daily sum of the number of issues on these exchanges. The visual match of this indicator to the Sentiment

[23] The values of the THiLoRatio indicator have been scaled up by a factor of 1.5 in this chart.

indicator[24] is not as good as with the THiLoDifSum indicator. Ninety percent of the post-1989 daily signals are the same.

The StormGuard® Sentiment indicator provides a higher annualized return; higher Sharpe ratio and lower drawdown and it outperforms the reference 60:40 portfolio more frequently than either the THiLoDifSum or the THiLoDifRatio indicator.

Figure A-4.



Indicators Which Measure the Economy

WLIG+ - This is a weekly indicator developed by van Vuuren and Vrba[25] from ECRI's Weekly Leading Indicator Growth index. A positive value is bullish. The WLIg+ indicator can be calculated from April 1969.

The Economic Cycle Research Institute publishes the Weekly Leading Indicator Growth index, generally on Friday mornings, based on data through the end of the prior week. *Signals should be measured as of the release date.* Month-end signals are therefore lagged by at least one week and potentially by as much as two weeks.

Initial Unemployment Claims (IUC) Indicator[26]. The indicator is bullish if the most recent corrected value of seasonally adjusted initial unemployment

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[24] The values of the THiLoRatio indicator have been scaled up by a factor of 10 in this chart.

[25] *Further Improving the Use of the ECRI WLI*, Dwaine van Vuuren and Georg Vrba, January 17, 2012.

[26] Al Zmyslowski, CIMI group, March 2015 and April 2016. Zmyslowski reports that the idea for the IUC timing indicator was stimulated by the Doug Short blog.

The cumulative data file is available at https://oui.doleta.gov/unemploy/claims.asp, but it tends to be a month behind. The most recent data can be gleaned from the weekly press releases at https://oui.doleta.gov/unemploy/archive.asp. Use the corrected data, which often differs from the data in the prior press release. The corrections are detailed in the press releases.

claims is less than 97% of the 22-week SMA of claims and bearish if the number of claims is more than 112% of the 22-week SMA of claims. The prior week's signal is used when the number of claims is within these limits.

Initial unemployment data are released each Thursday and reflect claims as of the prior week end. Data are often revised the following week and the corrections have been incorporated into the historical simulations, which would have been impossible if using the data live.

Signals are measured as of the release date.

Signal dates are month-end and reflect the number of claims as or five to twelve days earlier. The first historical signal was available on June 29, 1967, based on claims as of the week ending June 24, 1967.

The sensitivity to the indicator parameters in guiding the allocation between large cap US stocks and intermediate term government bonds was backtested from 1969. Three combinations of parameters were identified which provide slightly better performance. See Table A-5. All trade more frequently than Zymslowski's indicator.

Performance differences are small when each of the improved IUC indicators is incorporated into a composite indicator. Zmyslowski's recommended parameters are substantiated and are used henceforth.

Table A-5. Performance of the Initial Unemployment Claims Indicator, April 30, 1969 - June 29, 2018. Allocation is to large cap US stocks or intermediate term government bonds. Decisions and trades occur at month- end.

The composites shown at the end of this table are four variations of the IUC indicator plus AbsMom, 5AbsMom and DR*VOL.

SMA Interval	Lower Bound	Upper Bound	CAGR, %	Sharpe	MaxDD, %	Ulcer Index	Trades per year
26 weeks	0.99	1.16	10.67	0.48	0.41	11.3	0.8
	0.98		11.38	0.53	0.41	11.5	0.8
	0.97		11.33	0.53	0.41	11.5	0.8
	0.96		11.14	0.53	0.38	10.7	0.8
	0.95		11.37	0.53	0.38	10.5	0.8
26 weeks	0.99	1.12	11.08	0.51	0.33	8.7	1.2
	0.98		11.80	0.57	0.33	8.7	1.2
	0.97		11.93	0.59	0.33	8.4	1.2
	0.96		11.35	0.55	0.30	7.9	1.1
	0.95		11.40	0.56	0.30	7.9	1.1

Some unemployment data are available at FRED but the accuracy and latency are not known

26 weeks	0.99	1.08	11.72	0.57	0.34	8.1	1.7
	0.98		12.41	0.64	0.34	8.0	1.7
	0.97		12.14	0.63	0.34	7.6	1.7
	0.96		11.86	0.62	0.30	6.2	1.6
	0.95		11.73	0.61	0.30	6.2	1.6
26 weeks	0.99	1.04	11.75	0.61	0.30	7.8	2.3
	0.98		11.75	0.62	0.30	7.4	2.4
	0.97		11.54	0.62	0.30	6.6	2.4
	0.96		11.04	0.59	0.30	5.6	2.2
	0.95		10.70	0.57	0.30	5.7	2.2
22 weeks	0.99	1.16	10.02	0.42	0.50	13.3	0.8
	0.98		10.41	0.45	0.50	13.2	0.8
	0.97		11.19	0.50	0.50	13.2	0.8
	0.96		11.08	0.50	0.50	13.4	0.8
	0.95		11.08	0.50	0.50	13.4	0.8
22 weeks	0.99	1.12	10.49	0.47	0.44	10.9	1.3
	0.98		11.24	0.53	0.33	8.5	1.2
	0.97		12.04	0.59	0.33	8.1	1.2
	0.96		11.58	0.56	0.33	8.5	1.1
	0.95		11.44	0.55	0.33	8.5	1.1
22 weeks	0.99	1.08	11.29	0.53	0.41	10.2	1.8
	0.98		12.49	0.64	0.34	7.9	1.7
	0.97		12.74	0.67	0.34	7.4	1.7
	0.96		12.26	0.64	0.34	7.8	1.6
	0.95		12.39	0.65	0.30	6.5	1.6
	0.94		11.96	0.63	0.30	6.4	1.5
22 weeks	0.99	1.04	10.05	0.48	0.47	12.8	2.8
	0.98		11.16	0.58	0.36	9.1	2.6
	0.97		11.23	0.60	0.30	6.9	2.5
	0.96		10.82	0.58	0.30	7.5	2.2
	0.95		10.74	0.58	0.29	6.4	2.3

13 weeks	0.99	1.16	9.71	0.39	0.51	14.3	0.7
	0.97		10.03	0.41	0.51	14.6	0.7
	0.96		10.18	0.42	0.51	13.6	0.7
	0.95		10.13	0.42	0.51	13.8	0.7
13 weeks	0.99	1.12	10.60	0.46	0.49	12.7	1.2
	0.97		10.91	0.48	0.49	13.2	1.2
	0.96		11.46	0.53	0.45	11.8	1.1
	0.95		12.03	0.58	0.41	8.6	1.1
	0.94		11.81	0.56	0.41	9.1	1.0
13 weeks	0.99	1.08	10.97	0.50	0.51	12.5	2.0
	0.97		10.74	0.51	0.51	13.4	2.0
	0.96		11.75	0.59	0.33	8.1	1.8
	0.95		11.93	0.61	0.30	7..1	1.7
	0.94		12.32	0.65	0.30	6.0	1.6
	0.93		11.92	0.64	0.30	6.2	1.6
13 weeks	0.97	1.04	9.90	0.47	0.48	13.0	3.7
	0.96		11.50	0.63	0.29	6.2	3.1
	0.95		10.73	0.58	0.29	6.5	2.7
	0.94		9.99	0.53	0.30	6.0	2.3
	0.93		8.95	0.46	0.30	6.9	1.9
Composites of 33% IUC + 17% AbsMom + 17% 5AbsMom + 33% DR*VOL							
26 weeks	0.98	1.08	12.53	0.71	0.26	5.4	4.0, 84%
22 weeks	0.97	1.12	12.40	0.69	0.26	5.4	3.8, 83%
22 weeks	0.97	1.08	12.64	0.73	0.26	5.3	4.2, 85%
13 weeks	0.94	1.08	12.50	0.72	0.26	5.0	4.0, 79%

Composite Indicators. I advocate basing allocations on the recommendations of more than a single indicator because this has the potential to provide more reliable results than the recommendation of a single indicator.

Composite indicators are generally the equally weighted average of the signals of the component indicators.

Individual timing signals are generally binary, bullish or bearish, but the SPVOL algorithm provides signals which vary continuously between the extremes of bullish and bearish. Composite signals are not binary.

StormGuard® Armor. Juds weights the StormGuard® Standard, Momentum and Sentiment indicators to obtain the Armor composite indicator from which he computes the timing signals. Juds uses a fuzzy logic weighting scheme that involves twelve measures which are not otherwise identified.

Description of the Ranking Indicators.

August 3, 2018

The individual investor can emphasize performance, either return or risk adjusted return (Sharpe ratio.) He or she may prefer a concentrated portfolio because this tends to provide higher returns and lower transaction costs. He or she is happy to make frequent portfolio changes if this increases performance.

The fund manager must sacrifice some performance for capacity and implementation considerations[27]. (Capacity is the volume that a manager can transact without moving market prices substantially.) Capacity and implementation considerations also make it difficult for the fund manager to implement market timing.

The individual investor has the options of investing in a concentrated portfolio, in focused sector funds or in board-based funds such as those used in the SIMPLE portfolio. In our experience, backtested returns decline monotonically from a concentrated stock portfolio with risk control (e.g., 24% historical CAGR), to focused funds with risk control (e.g., 19% historical CAGR) to broad-based funds with risk control (e.g., 14% historical CAGR) but that the Sharpe ratios are all about unity. If the Sharpe ratios are similar, the concentrated stock portfolio must be twice as volatile as the portfolio of broad-based funds.

A concentrated stock portfolio with risk control may be the best choice for the individual investor who hopes to get rich quickly and who can tolerate high volatility. A portfolio of focused funds with risk control may be a better choice for the investor who desires less volatility. A portfolio of a few broad-based funds with risk control may be most appropriate for the patient investor who is seeks to outperform the traditional 60:40 portfolio in terms of return and volatility.

Defining Momentum

There are many momentum indicators and several momentum indices.

The first momentum indicators balance performance and capacity and are therefore more suitable for the fund manager. The FundX, SectorSurfer® and Antonacci indicators are more suitable for the individual investor who is able to neglect capacity considerations.

- The French data library, and the academic literature generally, measure momentum as the total return over eleven months. That is, the return is measured over the past year with the most recent month omitted.

  If momentum were being measured at the end of December; the total return would be measured over the January through November interval.

[27] FTSE Russell, "Factor Exposure Indices. Momentum Factor," August 2014. This is an excellent discussion although it only addresses historical performance over the 2001 – 2014 interval.

The French indices are capitalization weighted or equally weighted. Indices are reconstituted annually.

Multi-factor indices, e.g., small value, are identified as the intersection between/among factor ranked portfolios.

- The AQR momentum methodology is similar to the academic approach[28]. The stocks in the parent index are ranked by eleven months momentum and the top third are selected for the index. Stocks must trade at least $100,000 daily.

  Indices are capitalization weighted and reconstituted quarterly.

  AQR Momentum Index. 333 high-momentum companies are chosen from among 1,000 large and mid-cap US companies. The AQR Large Cap Momentum Style Fund tracks this index.

  AQR Small Cap Momentum Index. 666 high-momentum companies are chosen from among the next 2,000 US companies. The AQR Small Cap Momentum Style Fund tracks this index.

- Standard and Poors maintains two US momentum indices, a large cap and a mid/large cap index with histories from late 1984, and numerous foreign momentum indices. Momentum is measured as either the price or total return (there are separate price and total return indices) over 12 months, lagged by about two months[29].

  If the rebalancing date were March 24, 2014, the return would be calculated over the interval from January 31, 2013 through January 31, 2014.

  The risk adjusted momentum value is the 12-month return divided by the standard deviation of the daily price returns over the same 12-months.

  The Z-score for a stock is the risk adjusted return for that stock less the average of the risk adjusted returns of all stocks in the parent index divided by the standard deviation of the risk adjusted return of all stocks in the parent index. The Z-score measures the distance, in standard deviation units, from the mean of the distribution of the risk adjusted returns of all stocks in the parent index.

  Z-scores are limited to the range ± 3 by resetting values of more than 3 to 3 and scores of less than minus 3 to minus 3.

  The Momentum Score for the security is

  $1 + Z$, if Z is zero or positive; or

  $1 / (1 - Z)$, if Z is negative.

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[28] "AQR Momentum Indices - U.S. Equities Methodology Description."

[29] "S&P Momentum Indices Methodology", March 2017.

The securities in the parent index are ranked by Momentum Score and the top 20% are included in the momentum index. Twenty percent is a soft target as there are additional rules to reduce turnover. Indices are rebalanced on the third Friday of March and September.

No mention is made about whether this methodology applies to funds.

- The calculation of the MSCI Momentum Score for a security begins with the 12-month and 6- month local price performance without dividends[30].

  6-month Price Momentum = ((PT-1 /PT-7)-1) – (Local Risk-free Rate)

  12-month Price Momentum = ((PT-1 /PT-13)-1) - (Local Risk-free Rate)

  PT-1 = local price one month prior to the rebalancing date, PT-7 = local price seven months prior to the rebalancing date and PT-13 = local price thirteen months prior to the rebalancing date.

  The Local Risk-free Rate is the short-term rate in the local currency. For US stocks, the Local Risk-free Rate is the 3-month T-bill rate.

  The price performance values are divided by the annualized standard deviations of the weekly local price returns over the trailing 3 years and averaged to achieve a Z-score.

  $$Z = \{ \text{6-month Price Momentum} + \text{12-month Price Momentum} \} / \{ 2 \sigma \}$$

  Securities are ranked in terms of this Z score. For parent indices with many securities, the number of securities chosen for the momentum index is limited to 30% of the number of securities in the parent index.

  The MSCI USA Momentum Index, which is tracked by the iShares offering MTUM, holds about 125 securities.

  Z is limited to the range ± 3 by resetting values of more than 3 to 3 and scores of less than minus 3 to minus 3.

  The Momentum Score for the security is

  $1 + Z$, if Z is zero or positive; or

  $1 / (1 - Z)$, if Z is negative.

  Securities are assigned a relative weight equal to the product of the market capitalization in the parent index times the Momentum Score.

  Indices are typically recomputed semi-annually in May and November

  Whereas the MSCI momentum indices include only a portion of the securities in the parent index, the MSCI momentum tilt indices include all securities in the parent index with the securities weight as the product of market capitalization times the Momentum Score.

[30] "MSCI Momentum Indexes Methodology," June 2017.

The tilt indices have higher investment capacity than the momentum indices but likely have lower returns.

We have implemented the MSCI algorithm substituting the daily standard deviation over sixty market days and monthly rebalancing. When applied to a portfolio of equity and bond funds, the trends of the equity funds are reduced relative to the trends of the bond funds. The result is that the returns and drawdowns are reduced in comparison to other algorithms.

- It is unclear how Russell FTSE defines momentum. In one discussion, momentum is defined as the total return over eleven months[31]. In a more research-oriented discussion, it is stated that [32]

  We considered three absolute or total measures of momentum; the one-year cumulative return (Return) [PJL: one year minus the most recent month]*, the one-year Sharpe Ratio, and the ratio of the current price to the highest price over the last year (CH12 Ratio).*

  The Return measure of momentum has historically shown strong risk adjusted performance outcomes that are not primarily the result of country or industry effects. We prefer the use of Return to [the use of] Sharpe Ratio as a measure of momentum, despite both exhibiting similar historical risk adjusted performance outcomes, since the latter displays substantial industry and country effects.

  While the performance of Return and the CH12 Ratio is similar, the CH12 Ratio leads to momentum strategies with significant exposure to systematic factors.

  We highlighted the Residual Sharpe Ratio measure of momentum on which to construct momentum indexes, based on relatively low levels of turnover, volatility and similar historical performance to other momentum measures. Importantly and in contrast to traditional measures of momentum, the Residual Sharpe Ratio avoids time-varying exposure to systematic risk factors.

  We considered an illustrative set of indexes based on this factor and found that they exhibit a substantial exposure to momentum and relatively low levels of turnover for a momentum-based factor index. A broad semi-annually rebalanced momentum index offers a practical combination of high levels of momentum exposure and relatively low turnover outcomes that are robust to the timing of the semi-annual rebalance.

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[31] "Focused Factor Indexes, Methodology Overview," FTSE Russell, undated.

[32] "Factor Exposure Indexes, Momentum," FTSE Russell, August 2014

"Factor Exposure Indexes, Index Construction Methodology," FTSE Russell, August 2014. This report illustrates the construction of a value index.

The Residual Share Ratio measure of momentum was proposed by Blitz et al (2011).

$$R_t = \alpha + \Sigma_k \beta_k * F_{kt} + \varepsilon_t$$

where R_t is the stock local total return in period t; α is the stock specific return not explained by the risk factors; β_k is the stock exposure to risk factor k; F_{kt} is the return to risk factor k in period t, and ε_t is the residual return. We include two risk factors – the country return and global industry return respectively. We investigate momentum in two non-systematic sources of return; stock specific return (α) and residual return (ε_t).

My interpretation – the text is unclear - is that FTSE Russell calculates the Residual Sharpe measure of momentum in the following manner:

Rolling 12-month values of R_t are calculated for each of the 36 months ending the month prior to factor construction and a residual return determined. The mean and standard deviation of the 11-month time-series of residual returns forms the residual momentum measure (Residual Sharpe Ratio). – confirm with Blitz et al

- The *NoLoad FundX Newsletter* has been ranking funds for inclusion in portfolios since 1976[33]. The FundX score is the average of the returns over 1-, 3-, 6- and 12-months plus bonus points. If a fund were appreciating at a uniform 1% a month, the return would be 1% per month in each interval and the average of the monthly returns would be

  $$(1 + 1 + 1 + 1) / 4 = 1$$

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

  NoLoad FundX Newsletter allocates equally to five funds from among a hundred or so possibilities. Allocations are reviewed monthly, but funds are generally held for at least three months.

  The FundX approach is equivalent to averaging the annualized returns. Our implementation averages the returns. If a fund were appreciating at a uniform 1% a month, FundX indicator used here would be the average of

  $$(1.01^12 - 1) + (1.01^6 - 1) + (1.01^3 - 1) + (1.01^1 – 1)$$

  The average is 0.229/4 or 0.057. There are no bonus points.

- AnFundX or "annualized FundX" xxxxxxxxxxxxxxxx
- SectorSurfer® defines the trend of a security as the double exponential moving average of the daily return[34]. Juds observed that the value of the parameter defining this moving average, the "trend constant," affects the

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

[34] www.sumgrowth.com.

backtested investment performance and he introduced an optimization routine to adjust the trend constant semiannually. Juds calls this process "forward walk progressive tuning" or FWPT.

SectorSurfer® allocates to the top trending fund, chosen from a dozen candidates. Rankings are reviewed monthly.

Hysteresis may temporarily sustain a fund whose relative trend has slowed.

Since the double exponential moving average may be unfamiliar to readers, some explanation is in order.

The double exponential moving average, also known as the second order exponential moving average, is the exponential moving average of an exponential moving average. We therefore begin with the exponential moving average.

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 coefficients of 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.

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

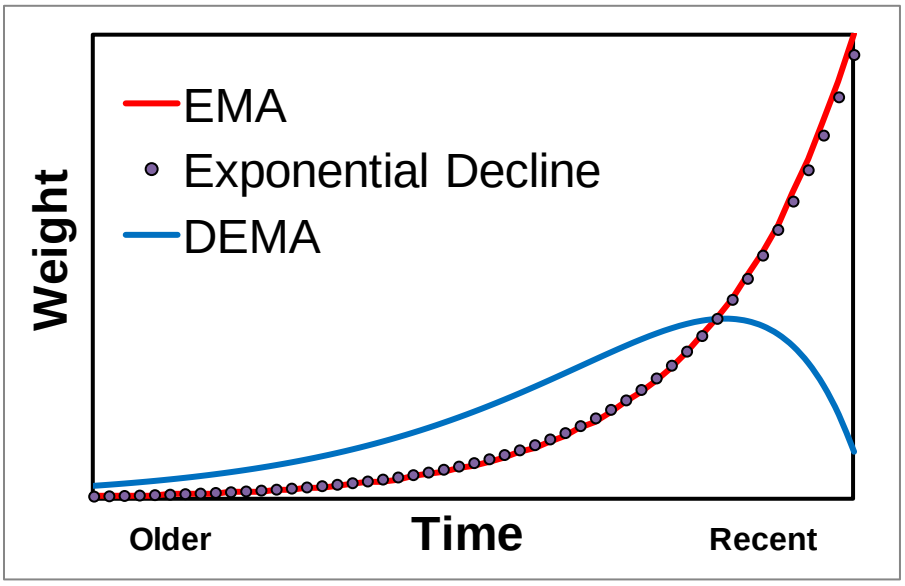
The double exponential moving average is equivalent to the weighted sum of the daily returns with weights defined by the blue line in Chart A-1[35].

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

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.

[35] This assumes that the smoothing factors are the same for both moving averages, which is not the case with all double exponential moving averages.

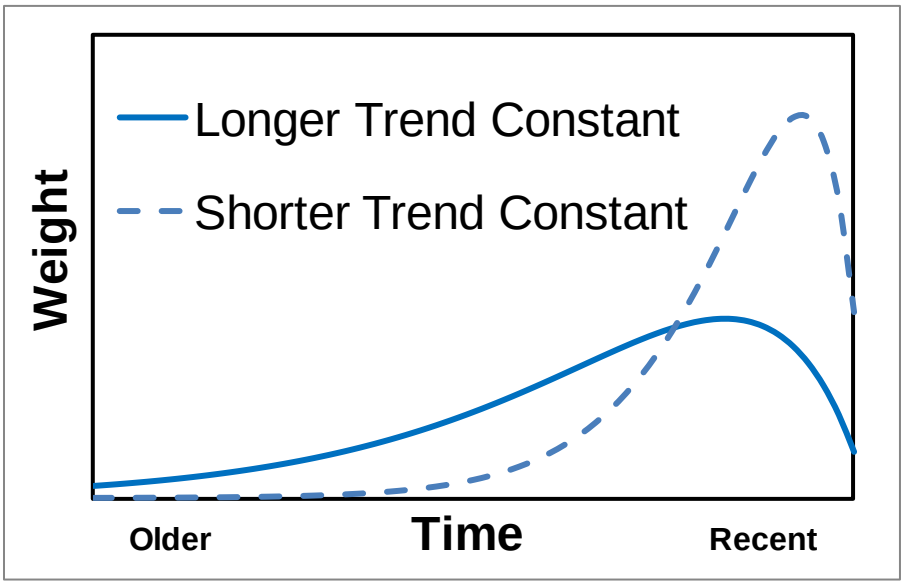
Chart B-1. Weighting Functions, Exponential Averaging. Reference: theory.xls.



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 B-2.

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

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



The DEMA calculation is illustrated in the shaded box below. The daily return is the value of the security today less the value of the security yesterday, adjusted for dividends.

The first step is to calculate the exponential moving average (EMA).

$$\mathrm{EMA(n)} = 21{*}\alpha{*}\mathrm{DR(n)} + (1\text{-}\alpha){*}\mathrm{EMA(n\text{-}1)};\ \mathrm{n\ increasing}$$

where α is the smoothing factor, DR is the daily return at day n, and EMA(n-1) is the smoothed value as of the prior day. The daily change is scaled by 21 market days to approximate the magnitude of a monthly change.

This is algebraically equivalent to defining EMA as the sum of the daily returns.

$$EMA = 21 * \sum W * Daily\ Return$$

where the weights are given by the red line in Chart B-1.

The first step is repeated, substituting the exponential moving average EMA for the daily returns DR. Smoothing twice is what makes the process "second order."

EMA2(n) = α * EMA(n) + (1-α) * EMA2(n-1); n increasing.

Equivalently,

$$EMA2 = \sum W * EMA$$

where the weights are again given by the red line in the chart B-1. Alternatively,

$$EMA2 = \sum W * Daily\ Return$$

where the weights are now given by the blue line in the chart B-1.

The following table illustrates the calculation using the dividend adjusted S&P 500 Composite, represented by VFINX, and α = 0.02. Both EMA and EMA2 are initialized by setting the oldest values equal to zero. Initialization is not important so long as many, a hundred or more, daily returns are included in the calculation.

DATE	VFINX	21* Daily Return	EMA	EMA2
9/1/1988	14.154		0.000000	0.000000
9/2/1988	14.494	0.50445	0.010089	0.000202
9/6/1988	14.554	0.08693	0.011626	0.000430
6/20/2013	146.335	(0.52225)	0.005413	0.021508
6/21/2013	146.720	0.05525	0.006410	0.021206
6/24/2013	144.940	(0.25477)	0.001187	0.020806

In SectorSurfer parlance, the "trend constant" equals 1/α.

Second order exponential averaging introduces a "lag" in the trend. The lag is about equal to the trend constant.

- **DEMAxx** is the double exponential moving average calculated in the same manner as SectorSurfer® except that the trend constant equals xx and is not optimized.
- **DemaOpt.** This is our implementation of a DEMA-type algorithm in which the trend constant is updated semiannually, analogously to FWPT.
- **RelMom.** Antonacci defines Relative Momentum as the total return of a mutual fund or ETF over the prior 12 months[36]. Allocations are reviewed monthly.

  Antonacci does not apply relative momentum to individual securities. In our experience, the RelMom algorithm does not perform as well as the FundX or DEMA algorithms with stocks and focused funds.
- **Combination algorithms**. We have explored two combination methodologies. The first postprocesses the equity curves generated by two or more ranking algorithms. This is called a "Combo" strategy.

  The second approach is to average the rankings of two or more ranking strategies. An equity curve is generated based on the average ranking. This is an "Ensemble" strategy.
- **Trendrating** allocation algorithm (www.trendrating.com) is a composite of eight indicators.
  1. Average Directional Index
  2. Exponential Moving Averages. The details are unknown. Mulloy's formulation[37] of this indicator is 3*EMA-3*DEMA+TEMA.
  3. Klinger Oscillator, which measures the ratio of the volume flowing into and out of a security divided by the price movement.
  4. Money Flow Index (volume weighted relative strength)
  5. Polarized Fractal Efficiency
  6. Price Rate of Change (price change over N periods; N is typically less than six months.)
  7. Relative Vigor Index.
  8. Aroon Indicator

  Trendrating is not applicable to mutual funds since some indicators require intraday prices.
- **Re-ranking by Volatility**. The goal is to emphasize those securities whose equity curves change steadily as opposed to those whose equity curves move in fits and starts.

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[36] Gary Antonacci, *Dual Momentum Investing*, McGraw Hill, 2015. Antonacci describes two methods. On p. 98, he describes what he does. On pp. 101 and 112, he describes a simplified approach for those using charts to get their signals. (Personal communication, March 24, 2016.)

[37] *Stocks & Commodities*, V12:2, February 1994

Re-ranking attempts to address the FIP problem. Da, Gurun and Warachka[38] show that momentum is a more reliable predictor of future returns when the historical equity curve is relatively smooth as opposed to when the equity curve includes large changes. Their hypothesis is that momentum exists, in part, because of investor inattention, that inattention is more likely when information is provided in small doses and that investor reaction to information is evidenced by changes to the equity curve.

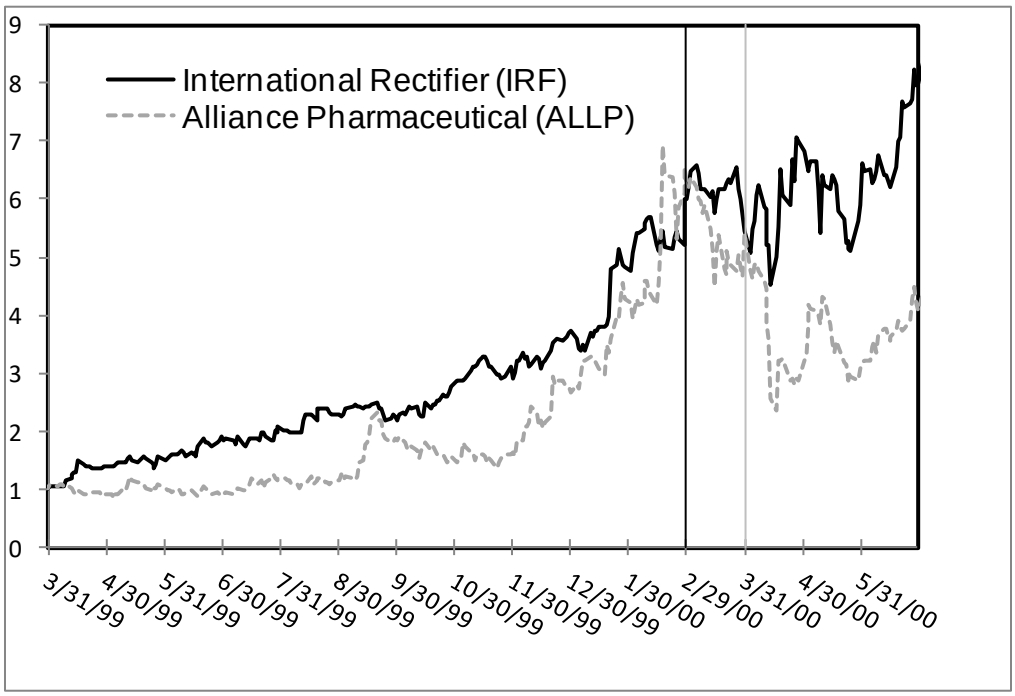
Da, Gurun and Warachka suggest an empirical measure of information discreteness

ID = sign of prior return * (%positive - %negative)

where %positive and %negative represent the percentage (or number) of days during the formation period with positive and negative returns.

The example provided by Gray and Vogel, which they say is "cherry picked," is the relative performance of International Rectifier and Alliance Pharmaceutical from April 1999 through March 2000. The chart shows that both stocks appreciated five-fold over the interval, but that International Rectifier grew steadily while Alliance achieved most of its growth in the last quarter.

Equity Curves for Two Stocks. Compare Gray and Vogel, *Quantitative Momentum*, Figure 8.2. These equity curves do not include dividends.



Source: IRF-201501.xlsx

[38] Zhi Da, Umit G. Gurun and Mitch Warachka, "Frog in the Pan: Continuous Information and Momentum," *The Review of Financial Studies* **27** (2014): 2171-2218.

The signal based on the academic momentum indicator (April 1999 – February 2000, one year excluding the most recent month) favors ALLP. The measurement point is indicated by the first vertical line and the signal date is indicated by the second vertical line.

The value of Alliance Pharmaceutical deteriorates rapidly thereafter while the value of International Rectified continues to grow. Clearly the more advantageous decision was to invest in IRF.

Signals at March 31, 2000. "2-12MOM" is the return over months 2 through 12.

	2-12MOM	12MOM	FundX	Dema20	Information Discreteness	2-12MOM Sharpe	12MOM Sharpe	K-ratio
IRF	5.98	5.45	6.48	0.008	26	0.230	0.202	7.5
ALLP	6.55	5.43	6.46	0.012	- 40	0.151	0.129	5.4
Signal	ALLP	Neutral	Neutral	ALLP	IRF	IRF	IRF	IRF

Source: IRF-201501.xlsx

The 12MOM and FundX signals are equivocal and the Dema20 signal favors ALLP. The information discreteness signal and the 12MOM Sharpe and 2-12MOM Sharpe signals[39] favor IRF.

Operationally (Gray and Vogel, Table 8.4), the FIP approach would be implemented by choosing, say, the top 12 stocks based on momentum and investing is the half of these with the largest ID.

Thanks to Don Maurer for providing the historical data for this analysis.

- No Skill. This algorithm chooses randomly, with replacement.

Portfolio Visualizer can handle which?

[39] 12MOM: average of the daily returns over the prior 12 months divided by the standard deviation of the daily returns over the same twelve months.

2-12MOM. average of the daily returns over prior months 2 through 12 divided by the standard deviation of the daily returns over the same eleven months.

