Taming Drawdowns, Improving Risk Adjusted Returns

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This is a working document. It is subject to change.

It likely contains errors and misinterpretations.

Introduction

The sun always rises but stocks rise only 54% of the time. It would be more accurate to say "stocks *have risen* 54% of the time" because projections of past market performance do not guarantee the future.

The performance of an investment strategy is usually evaluated over the long term to reduce the influence of short term variability. Our objective is to show that it is important to evaluate investment strategies over both the long and the short terms. An appreciation of what might happen over the short term is essential if you are to avoid the sorts of surprises that might cause you to abandon a good long term strategy.

Relative strength is our preferred tool for evaluating short term performance. We use relative strength to examine the performance of small value and small momentum strategies.

We show how relative momentum has signaled a move to defensive securities in times of market stress. Moving to defensive securities would have reduced the pain associated with bear markets.

We show that Level3[2] portfolios suffer severe drawdowns. Our concern is that severe drawdowns increase the risk of panic selling in the depths of a bear market. As the Pinkerton vignette[3] illustrates, those who sold in 2008 and did not re-enter the market until 2010 locked in a substantial loss.

The usual approach to mitigating drawdowns is to dilute the equity portfolio with defensive securities, typically bonds. A permanent allocation to defensive securities reduces the long term return.

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

[3] Charles Rotblut, "Allocating to Manage Risk. A Case Study," *AAII Journal*, July 2017.

Nicholas timing and relative momentum would have controlled downside risk more effectively than an allocation to bonds and there would have been less reduction in the return.

Level3 portfolios with risk control would have exhibited smaller drawdowns while producing more return than conventional benchmarks.

We show that a portfolio of three equity funds, with allocation managed by relative momentum, provides returns which are competitive with Level3 portfolios and superior Sharpe ratios and drawdowns.

We show that the Pinkertons could reduce drawdowns and the risk of running out of money by managing their portfolio using relative momentum.

We extend the discussion to multi-factor investing and discuss the various indices which providers have developed.

Historical Performance of Small Value Stocks

As an AAII member, you know that stocks with small market capitalizations and stocks with high value metrics tend to appreciate faster than other stocks. Figure 1 shows that

- If you had invested $1 in large cap US stocks in December 1927 and had reinvested your dividends, your portfolio would have been worth $3,800 in December 2016 before expenses and taxes.
- If you had invested in small cap stocks with value characteristics (small value hereafter), your portfolio would have been worth $200,000.

You probably also know that stocks which are appreciating faster than other stocks – momentum stocks - tend to continue to provide outsized returns for weeks or even months. Figure 2 shows that

- If you had invested in small cap stocks with good momentum (small momentum hereafter), your portfolio would have grown to $1.6 million.

Cloonan recommends small stocks, value stocks and momentum stocks for Level3 portfolios.

The academic community has identified differences in size, differences in value and differences in momentum as the factors explaining most of the differences in the returns of stock portfolios[4].

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[4]Larry Swedroe, "Factors Allow Investors to Think Differently About Diversification," *AAII Journal*, April 2017. For a more comprehensive discussion and literature references, see *Your Complete Guide to Factor-Based Investing* by Andrew L. Berkin and Larry E. Swedroe, BAM Alliance Press, 2016.

Swedroe discusses factor underperformance by which he means the odds that a factor based strategy will underperform a strategy based on the opposite factor. For example, in his Table 4, Swedoe says that there is a 41% historical risk of size underperforming over one year and a 23% risk of underperforming over ten years. The interpretation is that there has been a 59% chance of a small cap fund providing a higher return than a large cap fund in any given year and a 77% chance over any ten years.

Level3 and factor-based investing present challenges and an opportunity.

- While the long term returns of small value and small momentum stocks are outstanding, relative returns over shorter intervals can be disappointing and large relative losses over a few years are not uncommon.
- The downside risks of small value, small momentum and Level3 portfolios are higher than the downside risks of conventional benchmarks.
- Individual investors should be able to extract more profit from Level3 and factor investing than a fund can because individuals are less affected by the issues of scale that plague fund managers.

We use dividend adjusted price data from the French data library at the Tuck School of Business, Dartmouth College, based on the 201705 CRSP database. Eugene Fama, Ken French and their students have been responsible for much of the research underpinning factor-based investing.

The French small value portfolio used here includes the stocks with book to market equity ratios in the top 30% and capitalizations in the smaller half. The French small momentum portfolio used here includes the stocks with eleven month returns in the top 30% and capitalizations in the smaller half[5]. Portfolios are capitalization weighted. The portfolios are long only and we compare returns to US large cap stocks.

These definitions are not universally accepted by index providers. Indeed, there does not appear to be any consistent definition for any of the factors.

Unlike the academic literature which uses long/short portfolios, the individual investor is more likely to be long only and to compare returns to the US large cap market.

We supplement the French data library with SBBI data for large cap US stocks and intermediate term US bonds[6]. Dividend adjusted price data for funds are from Investors FastTrack.

Our first example is small value stocks. The small value portfolio benefits from both the size and the value factors.

The black and green curves in Figure 1 illustrate how the values of small value stocks and large cap stocks would have evolved over the past eighty-nine years. The black and green curves are called “equity curves” in our parlance.

Underperformance depends on how “large” and “small” are defined and actual risks depend on the specific funds being compared.

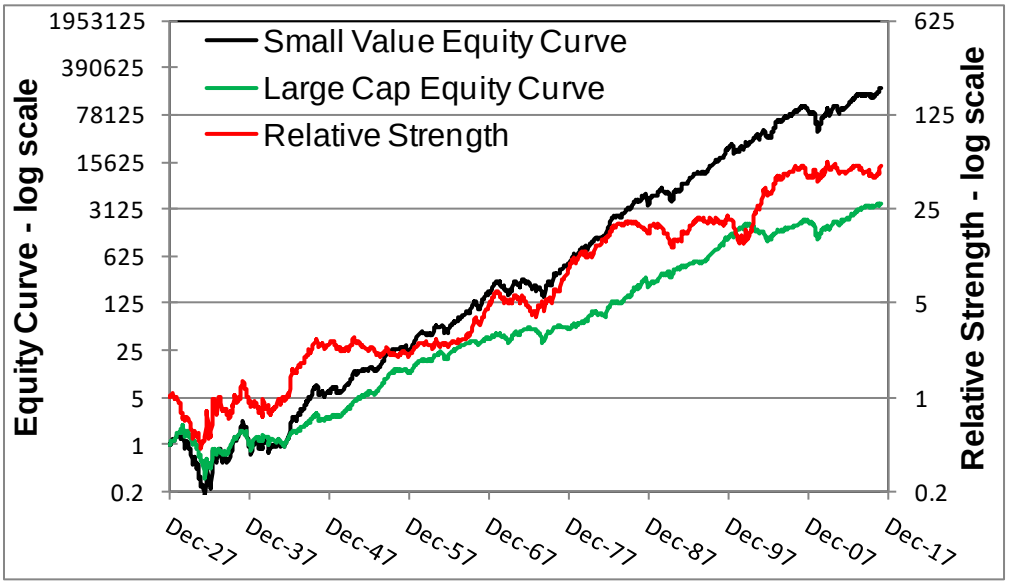
[5] The French data library measures momentum as the total return over eleven months, the past year omitting the most recent month. Alternate definitions of described in the extended version of this article.

[6] *Stocks, Bonds, Bills and Inflation Yearbook*, Ibbotson Associates. The returns of large cap stocks and of intermediate term bonds are represented by two Vanguard funds, VFINX and VBMFX, after 1988.

The red curve is the "relative strength." Relative strength is a ratio. It is, in this instance, the equity curve of small value stocks divided by the equity curve of large cap stocks.

Changes in relative strength highlight short term changes in the return of small value stocks relative to the return of large cap stocks. Small value stocks are providing a higher return than large cap stocks when the relative strength is rising, and vise versa.

Figure 1. Equity Curves (left axis) of Small Value and Large Cap Stock Portfolios and the Relative Strength (right axis) of Small Value Stocks versus Large Cap Stocks. Vertical changes represent percentage changes since the scale is logarithmic.



The relative strength varies over time. This is characteristic of all factor strategies.

There are decade long periods of rising relative strength; small value stocks are providing more return than large cap stocks in these intervals. There are periods, 1947-1966 and 2006-2016 for example, when the relative strength curve is flat, indicating that differences in return are modest. And there are periods when the small value portfolio lost significant value relative to the value of the large cap portfolio. Losses are indicated by the declines in relative strength in 1937-39, 1971-73, 1989-90, and 1998-99.

Example. The value of the small value portfolio was worth 1.00 in December 1927 and 2.164 in March 1937 and declined to 0.831 in August 1939. This is a drawdown of 61.6%. The value of the large cap portfolio suffered a drawdown of 29.0% over the same interval. The relative strength (relative value) of the small value portfolio declined from 1.336 to 0.722, a relative loss of 46.0%.

	March 1937	*August 1939*	*Change*
Small value portfolio	*2.164*	*0.831*	*-61.6%*
Large cap portfolio	*1.620*	*1.151*	*-29.0%*
Relative strength	*1.336*	*0.722*	*-46.0%*

One plus the change in relative strength is numerically equal to the ratio of 1 plus the change in the value of the small value portfolio divided by 1 plus the change in the value of the large cap portfolio. That is, (1-0.616) / (1-0.290) -1 equals -0.46.

This small value portfolio has provided a higher return than large cap stocks in 64% of the rolling 3-year intervals and in 72% of the rolling 5-year intervals. These percentages represent the historical odds of making money by changing from large cap stocks to this small value portfolio.

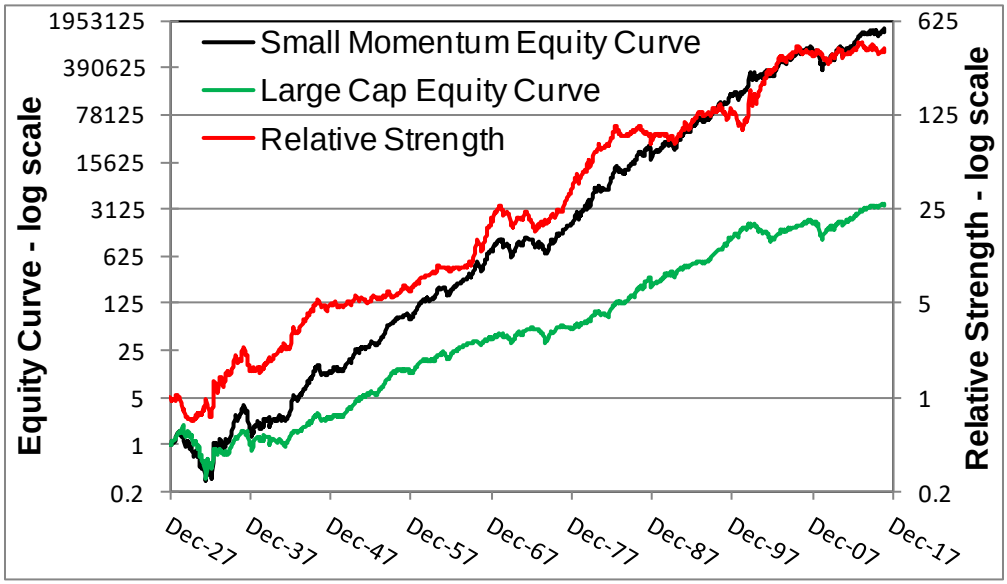
Historical Performance of Small Momentum Stocks

The small momentum portfolio benefits from the size and momentum factors.

Figure 2 compares the historical performance of small momentum stocks to that of large cap stocks. The value of the small momentum portfolio would have grown from $1 to $1.5 million over eighty-nine years. This growth rate easily eclipses the growth rate of both large cap and small value stocks.

The plot of relative strength in Figure 2 shows that the relative performance of small momentum stocks is time varying. A rising relative strength identifies the periods when small momentum stocks outperformed large cap stocks. The flat relative strength after about 2005 shows an interval when small momentum stocks provided about the same return as large cap stocks. Declines in relative strength in 1937-38 and 1969-73 identify periods when the value of the small momentum portfolio lost 35% of its value relative to the large cap portfolio.

Figure 2. Equity Curves (left axis) of Small Momentum and Large Cap Stock Portfolios and the Relative Strength (right axis) of Small Momentum Stocks versus Large Cap Stocks.



This small momentum portfolio has provided a higher return than large cap stocks in 78% of the rolling 3-year intervals and in 87% of the rolling 5-year intervals.

Small value and small momentum stocks have provided substantial extra return over long intervals but have disappointed over short intervals. Because of the variability of relative return, small value and small momentum strategies are most appropriate for patient investors with long time horizons or with enough resources to be able to weather periods of disappointment.

Defining Momentum

There are different constraints on individual investors and fund managers when exploiting investment factors.

The individual can emphasize performance, either return or risk adjusted return (Sharpe ratio.) He or she is likely to prefer a concentrated portfolio because this tends to provide a higher factor exposure, better performance and lower transaction costs. He or she is likely to prefer more frequent portfolio review because this increases performance.

The fund manager must sacrifice some performance for capacity and implementation considerations[7]. (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 dynamic risk control.

[7] 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 individual investor has the options of investing in a concentrated portfolio, in funds focused on particular sectors 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 nearly twice as volatile as the broad based fund portfolio.

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 very 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 both return and volatility.

There is no agreement as to how momentum should be measured nor is there agreement as to how momentum indices should be constructed. We find it odd that index providers have yet to marry capacity considerations with the FundX, SectorSurfer® and/or Antonacci algorithms. There has been less and probably insufficient examination of momentum in the context of funds.

The first approaches balance performance and capacity and are therefore more suitable for the fund manager. The FundX, SectorSurfer® and Antonacci definitions are for the individual investor and 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 for the January through November 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 method is similar to the academic approach[8]. The parent index is ranked by eleven months momentum and the top third of the funds 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.

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

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 measures as either the price or total return (there are separate price and total return indices) over 12 months, lagged by about two months[9]. For example, if the rebalancing date is 03/24/2014, the return is calculated between January 31, 2013 and 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. (I suspect that this is daily price return or daily total return, depending of which index is being determined.)

  The Z-score for a particular 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.

  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[10].

  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)

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

[10] "MSCI Momentum Indexes Methodology," September 2014.

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 = { 6-month Price Momentum + 12-month Price Momentum } / { 2 σ }

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 particular 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 of the securities in the parent index with the securities weight as the product of market capitalization times the Momentum Score.

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[11]. In a more researcher oriented discussion, it is stated that [12]

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

We considered three absolute or total measures of momentum; the one-year cumulative return [PJL: one year minus the most recent month] *(Return), 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 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.

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:

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[12] "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.

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[13]. The FundX score is the average of the average monthly returns over 1-, 3-, 6- and 12-months plus bonus points. 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

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

  NoLoad FundX Newsletter employs a concentrated portfolio, allocating 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.

  Our implementation is similar but different. Our 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.

- SectorSurfer® defines the trend as the double exponential moving average of the daily return[14]. The parameter defining this moving average, the "trend constant," is optimized semiannually during the simulation.

  SectorSurfer® allocates to the top trending fund, chosen from a dozen candidate funds. Rankings are reviewed monthly. Hysteresis may temporarily sustain a fund whose trend has slowed.

- Antonacci defines relative momentum as the total return of a mutual fund or ETF over the prior 12 months[15]. Allocations are reviewed monthly.

  Antonacci does not apply relative momentum to individual securities. In our experience, his algorithm does not perform as well as the FundX or SectorSurfer® algorithms with stocks and focused mutual funds.

Multi-Factor Portfolios

The variability or "cyclicality[16]" of relative strength seen in Figures xx and xx is characteristic of factor investing generally. Since factor portfolios tend to have

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

[14] www.sumgrowth.com.

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

low correlation to one another, a combination of portfolios each of which focuses on a different factor might reduce cyclicality and provide a more reliable performance.

An obvious alternative solution, moving between one factor portfolio or another depending on which has the higher trend as well be demonstrated in the next section, is rejected as unworkable by the index providers. It might be useful to further test trend following.

There are two fundamental approaches to incorporating several factors into an investment strategy.

The first might be called a fund of funds strategy. An example of the fund of funds strategy is ticker VMOT which was by Alpha Architects in May 2017 to exploit value/momentum synergism.

SPVM, which follows a value/momentum intersection index, was introduced in April 2017.

Gray founded Alpha Architects. Gray and Vogel[17] show that a combination of value and momentum portfolios would have provided a more reliable return over the interval from 1982 – 2014. Results from their Tables 4.6 though 4.8 appear in rows 2 – 4 of Table 1.

Table 1. Performance Statistics for Value, Momentum and a 50:50 Combination. "60Wins" is the frequency with which the return exceeds the return of large cap stocks over a 60-month rolling interval.

1982 – 2014	CAGR, %	Sharpe	MaxDD, %	Frequency of 60Wins
US Large Cap	11.71	0.54	51	Reference
Momentum (G&V)	13.75	0.60	48	
Value (G&V)	12.79	0.59	50	
Combination (G&V)	13.49	0.64	49	
Small Momentum	17.50	0.69	54	72
Small Value	16.06	0.69	60	72
Combination	16.89	0.70	56	74
1928-2016				
US Large Cap	9.71	0.41	83	Reference
Small Momentum	17.29	0.63	81	87

[16] Cyclicality. Of or denoting a business or stock whose income, value, or earnings fluctuate widely according to variations in the economy or the cycle of the seasons: - dictionary.com.

[17] Wesley R. Gray and Jack R. Vogel, *Quantitative Momentum,* Wiley, 2016.

Small Value	14.70	0.50	89	72
Combination	16.14	0.57	85	82

Our results in Table 1 confirm Gray and Vogel. An equal weighting of value and momentum portfolio provides a return and maximum drawdown which is intermediate between the statistics of the small value and small momentum portfolios and a slightly larger Sharpe ratio than either.

Since the Sharpe ratio is higher with the combination even though the return is lower, the performance of the combination must be more regular over time than either value or momentum and there must be synergism in the 1982-2014 interval.

Over the longer interval from 1928 however, the statistics of the combination degrade compared to the statistics of this small momentum portfolio. This result suggests that there is no synergism in earlier time intervals.

The second approach to incorporating more than one factor into an investment strategy is to combine value and momentum by excluding value stocks with low or negative momentum and momentum stocks with growth characteristics[18]. That is, stocks would be separately ranked in terms of value and momentum factors and the stocks at the intersection between the highly value stocks and the highly ranked momentum stocks for the multi-factor portfolio.

Some factors, quality and low volatility for example, tend to be positively correlated and a fund of funds approach should be effective. In other situations, the following figure illustrates that the composite or fund of funds approach is inferior[19].

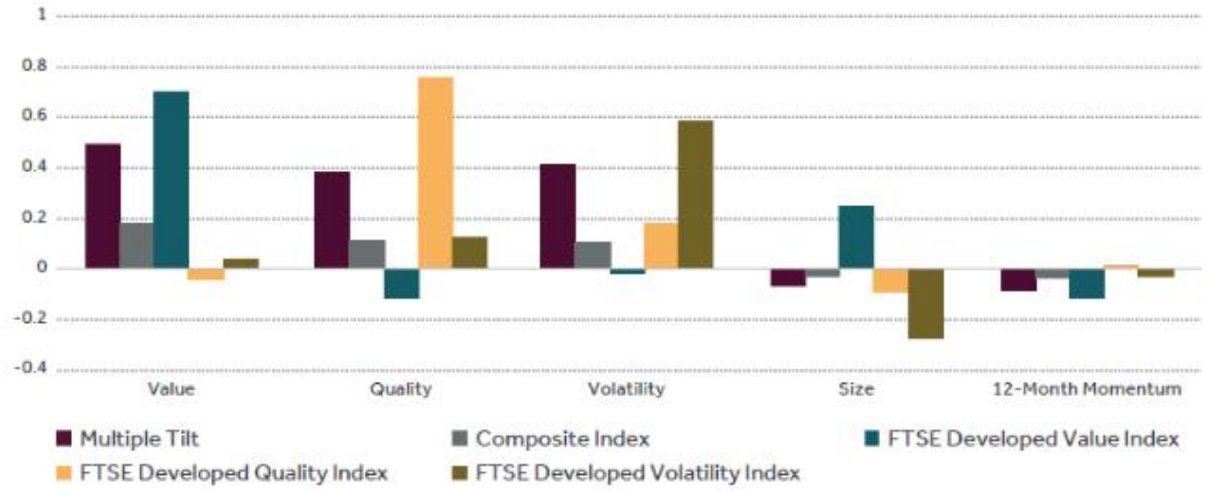
The goal was to construct an index exploiting the Value, Quality and Low Volatility factors. The purple bars show the factor exposure that was achieved with the selective approach (which FTSE calls “multiple tilt”). Moderate exposure was achieved with respect to the Value, Quality and Low Volatility factors and slight negative exposure to the Size and Momentum factors.

18Gregg S. Fisher, Ronnie Shah and Sheridan Titman, “Combining Value and Momentum,” *Journal of Investment Management*, forthcoming. Last revised: 29 Apr 2017.

Andrew Innes, “The Merits and Methods of Multi-Factor Investing,” S&P Dow Jones Indices, 2017.

[19] “Factor Exposures of Smart Beta Indexes, FTSE Russell, 2015

Figure 14. FTSE Developed active factor exposure: Single factor indexes and multiple tilt approach



In contrast, the Composite Index, a fund of funds index, shows lower net exposure to the Value, Quality and Low Volatility factors.

This selective or intersection approach is how the multifactor portfolios are constructed in the French data liberty.

The intersection approach is preferred by several index providers. For example, Northern Trust Asset Management uses the intersection approach when building multi-factor strategies[20].

The following chart illustrates the benefits that Northern Trust Asset Management achieves on combining Quality with other factors. Northern Trust's factor definitions are proprietary.

[20] Michael R. Hunstad, "Answering the Toughest Questions on Factor Investing," Northern Trust Asset Management, July 20, 2017 webinar.

MULTI-FACTOR CONSTRUCTION REDUCES EFFECTS CYCLICALITY

Our research has demonstrated that Quality is a complement to other factors as it historically increased return, reduced volatility, and mitigated the effects of other factor cycles.

The Impact of Quality on Annualized Returns

Period	Size	Value	Momentum	Low Volatility	Dividend Yield	Quality & Size	Quality & Value	Quality & Momentum	Quality & Low Vol	Quality & Dividend
1979 to 1982	8.4%	1.9%	16.1%	0.7%	-4.1%	18.2%	10.9%	20.9%	4.4%	6.2%
1983 to 1986	-3.5%	29.5%	8.2%	29.6%	21.4%	7.5%	31.9%	20.0%	29.8%	30.0%
1987 to 1990	-8.3%	13.8%	21.9%	26.0%	7.0%	1.1%	19.5%	25.4%	27.4%	21.3%
1991 to 1994	5.3%	13.4%	5.9%	-1.7%	0.0%	9.4%	15.1%	13.1%	6.1%	7.2%
1995 to 1998	-7.2%	8.7%	16.4%	10.2%	4.7%	-4.8%	12.4%	17.4%	13.4%	12.0%
1999 to 2002	6.5%	33.4%	29.8%	26.2%	15.7%	19.7%	36.2%	29.7%	30.2%	26.4%
2003 to 2006	4.0%	6.4%	-0.7%	-5.7%	-3.6%	6.2%	8.6%	3.6%	0.7%	2.4%
2007 to 2010	3.5%	1.3%	-11.1%	-10.6%	-4.9%	10.4%	4.0%	-2.5%	-3.9%	-1.3%
2011 to 2014	-2.1%	5.3%	9.9%	11.6%	1.7%	1.2%	7.7%	9.8%	11.9%	7.5%
2015 to 2016	2.5%	13.8%	5.3%	12.5%	7.2%	4.1%	11.1%	4.4%	10.6%	8.8%

The graph does not show actual performance results. For illustrative purposes only. Please see important information on hypothetical returns at the end of this presentation. Note: Russell 3000 index data is shown. Past performance is no guarantee of future results. Index performance returns do not reflect any management fees, transaction costs or expenses. It is not possible to invest directly in any Index.

Source: Northern Trust Quantitative Research, Data as of 12/31/2016.

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Northern Trust sponsors small value (TILT), foreign developed markets (TLTD), and foreign emerging markets (TLTE) funds but no fund which exploits the benefits of Quality mixed with other factors.

Standard and Poors has developed a Value and Momentum index which selects 200 stocks from the S&P 500 Composite based on a value score and selects the hundred of these with the highest momentum score[21]. A brand new ETF, Powershares S&P 500 Value and Momentum Portfolio (SPVM) tracks this index.

Standard and Poors has also developed a Quality, Value and Momentum Index[22].

The S&P Value and Momentum index is a subset of the parent index. Choosing a subset achieves factor exposure but could reduce sector or geographic diversification and could have capacity issues. A *tilt index* is constructed from all of the stocks in the parent index thereby reducing diversification and capacity concerns. The index provider change from capitalization weighting to weights which overweight or underweight factor characteristics.

The Russell 1000 Momentum Focused Factor Index is an example of an intersection tilt index. It targets the quality, value, size and momentum factors to provide an index with momentum exposure and reduces cyclicality.

Index construction by the following FTSE Russell graphic for Macy's stock, date unspecified. The first step is to determine Quality, Value, Size and Momentum

[21] See us.spindices.com/indices/strategy/sp-500-high-momentum-value

[22] S&P Quality, Value & Momentum Multi-factor Indices Methodology

scores for Macy's, and for all of the other stocks in the parent (Russell 1000) index, and to translate these scores into factor multipliers. The momentum multiplier for Macy's stock is quite low in this example.

For each stock, a product of its current weight in the parent (Russell 1000) index times each of the multipliers is determined. This product becomes the initial relative weights of each stock in the tilt index. After consideration of diversification and other constraints, final weights are determined.

This process reduces Macy's weight five fold in the focused momentum index, from 0.05% in the original index to 0.01% in the focused index.

The same process would increase Macy's weight in the FTSE Russell Low Volatility Focused Factor Index six fold.

Stock example: Macy's

	Russell 1000 Low Volatility Focused Factor Index	Russell 1000 Yield Focused Factor Index	Russell 1000 Momentum Focused Factor Index
Starting Weight (Russell 1000 Index market cap)	0.05%	0.05%	0.05%
Multiplied by	x	x	x
Tilt market cap exposures by multiplying by common factor scores	Quality 0.47 x Value 1.0 x Size 0.48	Quality 0.47 x Value 1.0 x Size 0.48	Quality 0.47 x Value 1.0 x Size 0.48
Magnify factor exposure by tilting towards focused factor	x Low Vol 0.51 x Low Vol 0.51	x Yield 0.86 x Yield 0.86	x Momentum 0.01
Rescale Weights			
Adjusted Weight	0.21%	0.83%	0.01%
Narrow the Index[3]	✓	✓	✗
Apply Constraints[4]	✓	✓	✓
Final Weight	0.30%	1.03%	0.01%

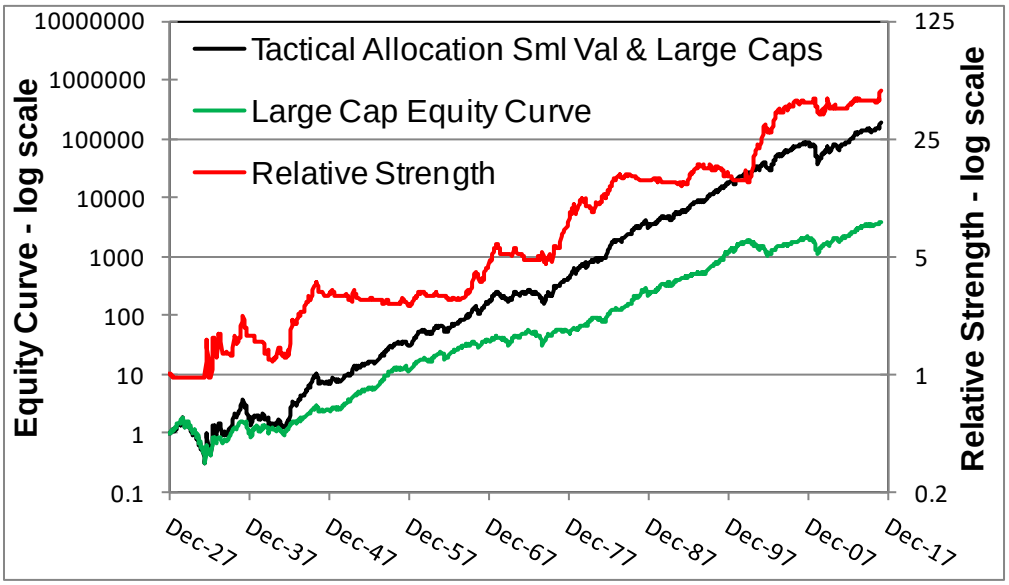
Information provided is for illustrative purposes only.

Deutsche X-trackers ETFs are based on FTSE/Russell indices which use the intersection approach to multi-factor investing.

Using Relative Strength to Reduce Underperformance of Small Value Stocks

The underperformance or cyclicality of small value stocks relative to large cap stocks could have been reduced by tactical allocation between small value stocks and large cap stocks. The tactical allocation equity curve in Figure 3 was constructed by allocating the portfolio to small value stocks when the momentum of small value stocks exceeded the momentum of large cap stocks and to large cap stocks otherwise[23].

Figure 3. Equity Curves (left axis) of the Tactical Allocation Portfolio and of the Large Cap Portfolio and the Relative Strength (right axis) of the Tactical Allocation Portfolio versus Large Caps.



Source: Fama French Portfolios.xlsb, Workbook Size and Book to Market.

By comparing Figures 2 and 3, it can be seen that tactical allocation reduces the declines in relative strength.

- The small value investor would have lost 46% relative to large cap stocks during 1937-39, 30% during 1971-73, 32% during 1989-90 and 35% during 1998-99. Tactical allocation would have reduced losses to 45, 14, 6 and 11% relative to large cap stocks.
- The small value investor would have gained 11% relative to large cap stocks between 2010 and 2016. The tactical investor would have gained 29% relative to large cap stocks.

[23] We determined momentum for large cap and small value stocks at the end of each month as the average total return over the prior 1-, 3-, 6- and 12-months. This algorithm has been used by the *FundX Newsletter* since the 1970s. Portfolio Visualizer supports this algorithm although we did not use that software for this example.

- Notwithstanding the improved relative strength, there was only a slight reduction in long term wealth ($200,000 is reduced to $183,000.)

Table 2. Mitigation by Timing or by a 40% Static Bond Allocation. "Wins" is the frequency with which the return of the indicated portfolio exceeds the return of large cap stocks over a 36-month rolling interval. "Decline" is the frequency with which the relative strength versus large cap stocks declines 10% over a 36-month rolling interval. Nicholas timing is defined in the section "Mitigating Drawdowns."

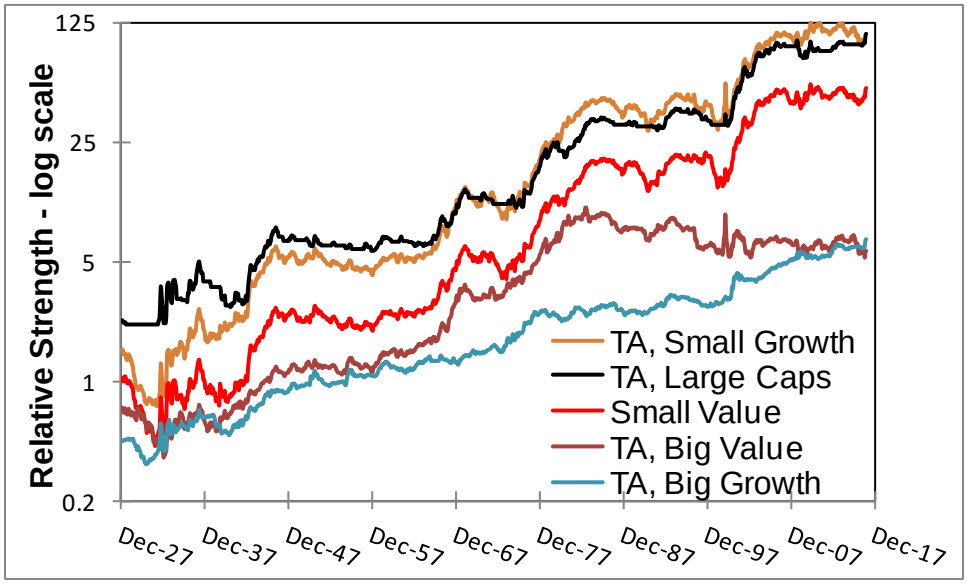
1928 - 2016	Wealth	CAGR, %	Sharpe	MaxDD, %	Frequency of Wins	Frequency of 10% Decline in Rel Str
US Large Cap	3,800	9.7	0.41	83	Reference	Reference
40% bonds	1,300	8.4	0.47	62	33	30
Nicholas Timing	10,600	11.0	0.61	48	51	12
RelStr vs bonds	5,300	10.1	0.58	50	43	26
Small Value	200,000	14.7	0.50	89	64	18
Nicholas Timing	250,000	15.0	0.63	72	67	21
RelStr vs bonds	490,000	15.9	0.64	64	67	21
Big Value	20,500		0.43	89	68	14
Nicholas Timing	70,000		0.65	63	72	12
Small Growth	1,400		0.31	88	43	42
Nicholas Timing	6,300		0.42	63	50	38
Big Growth	2,300		0.39	82	37	10
Nicholas Timing	7,500		0.57	47	43	22
TA: Small Value & Large Cap	183,000	14.6	0.52	82	60	9
Nicholas Timing	364,000	15.5	0.68	66	65	16
RelStr vs bonds	184,000	14.6	0.60	53	61	24
TA: Small Value & Small Growth	302,000		0.52	87	65	16
Nicholas Timing	321,000		0.64	69	64	21
TA: Small Value & Big Value	33,000		0.46	87	65	17
Nicholas Timing	92,000		0.63	56	69	18
TA: Small Value & Big Growth	58,000		0.50	84	76	6
Nicholas Timing	55,000		0.73	57	80	14
Small Momentum	1.46 mil	17.3	0.63	81	78	10
40% bonds	62,800	13.2	0.67	59	67	15
Nicholas Timing	1.59 mil	17.4	0.73	57	80	12
RelStr vs bonds	0.73 mil	16.4	0.70	54	73	18
Small Value & Small Momentum	609,000		0.57	85	72	12
Nicholas Timing	668,000		0.69	64	73	15

Source: Monthly Allocations July 2017.xlsb

Table 2 summarizes performance statistics for tactical allocation between small value stocks and other portfolios. Tactical allocation with large cap stocks or with big growth stocks leads to a smoother relative strength (Figure 4) and to fewer declines in relative strength (Table 2).

Tactical allocation vis-à-vis big growth stocks provides the smoother relative strength and it more frequently outperforms large cap stocks over rolling 36-month intervals but tactical allocation vis-à-vis large cap stocks would have provided a higher return.

Figure 4. Relative Strength versus Large Cap Stocks for Four Tactical Allocation Strategies. The curves have been offset from one another for clarity. The more linear the curve the more uniform the return differential compared to large cap stocks.



Source: Monthly Allocations March2017.xlsb, workbook Frequency.

Mitigating Drawdowns

"Drawdown" is the difference between the current value of a portfolio and the largest prior value of the portfolio. The drawdowns associated with factor-based portfolios can be large.

Although drawdowns represent only paper losses for the buy and hold investor, drawdowns are unnerving nonetheless. Investors need to be aware of the size of the drawdowns that their portfolio might experience and they need a drawdown strategy. Having no strategy can lead to panic selling at market bottoms and underperformance when the market recovers.

Cloonan argues that the largest investment risk is not accumulating enough for retirement by the time that you begin distributions. If you cannot save more and if you cannot reduce or delay required distributions, your only alternative is to seek higher returns. Higher returns are often associated with larger drawdowns.

It is probably impossible to eliminate drawdowns entirely but there are ways to mitigate them. For example, one could

- Include a permanent allocation to defensive securities. The traditional 60:40 portfolio is an example of this approach.
- Hedge the portfolio[24].
- Vary the allocation to defensive securities in response to market conditions. This approach is known as "market timing" or "dynamic risk control."

The standard by which a risk control strategy should be evaluated is whether it would have reduced drawdowns more effectively than other mitigation strategies while preserving more of the return than other strategies.

The Nicholas timer recommends stocks when the average total return of US large cap stocks over the prior 1-, 3-, 6- and 12-month intervals is positive and recommends intermediate term bonds when the average total return of large cap stocks is negative[25]. This algorithm is of the same form as the allocation algorithm used by the FundX Investment Group since the 1970s but the Nicholas timer bases the average return on a different risk index and uses the algorithm for a different purpose.

The Nicholas timer adjusted the bond allocation once every eight months on average over the eighty-nine year interval.

FundX momentum is the average of the 1-, 3-, 6 and 12-month total returns. The FundX Relative Momentum (FundX RM) timer compares the momentum of

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[24] Hedging using protective puts is described in the Swab blog at swanglobalinvestments.com. Over the past twenty years, the Swan Defined Risk Strategy has slightly exceeded the total return of US stocks net of fees with half of the volatility. The largest annual losses were 5% (2008 and 2011).

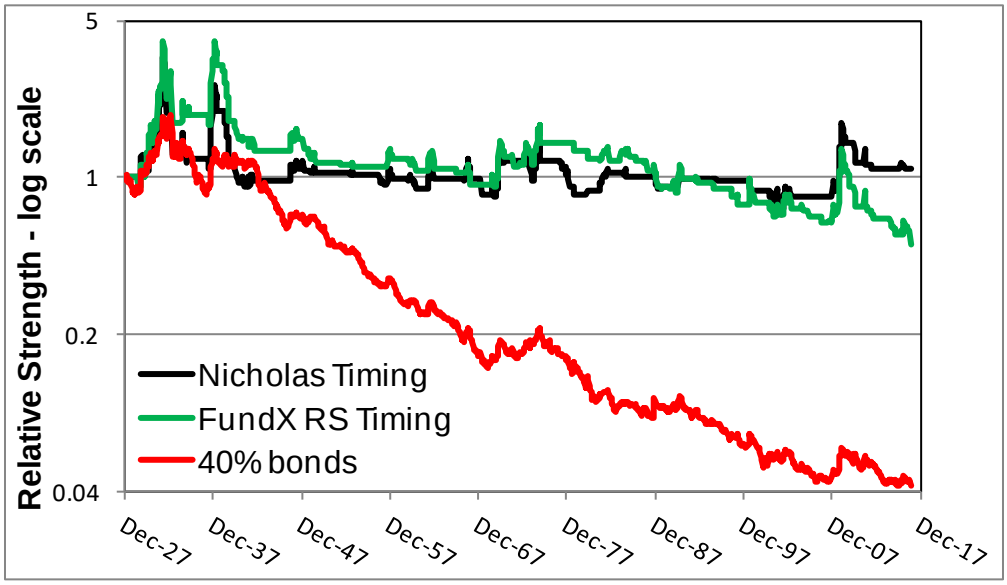
[25] John B. Nicholas, "Market Timers Yet Again," AAII Silicon Valley CIMI Group, August 10, 2015.

a portfolio to that of a bond fund and recommends investing in the portfolio when the portfolio has the higher momentum and in the bond fund when the bond fund has the higher momentum.

There are other momentum algorithms and there are timers based on volatility, economic data and market sentiment.

We compare FundX RM and Nicholas timing in Figure 5 to mitigation by a static, permanent 40% allocation to intermediate term bonds.

Figure 5. Relative Strength of Two Timed Small Momentum Portfolios and the Relative Strength of the Small Momentum Portfolio plus 40% Bonds. The relative strengths are being compared to the unmanaged small momentum portfolio.



Source: Monthly Allocations July2017.xlsb

The relative strength of the Nicholas timer (the black line) rises sharply at times, indicating downside protection in a falling market, and falls equally sharply at other times, indicating that the timer had been fooled by a moderate market decline and had stayed too long in cash as the market recovered.

Because the relative strength with market timing is not constant, the effect of timing on return depends on the interval tested. For example, the relative strength is less than one in December 2006 which means that Nicholas timing would have lost wealth relative to the untimed portfolio as of this date. But ten years later the relative strength is greater than one and Nicholas timing would have increased wealth.

The green line shows a pronounced downward trend meaning that the timed portfolio has a tendency to lose value relative to the untimed portfolio. The average annual decline rate is 0.8%. The average decline rate could be thought of as the cost of insuring against severe drawdowns.

The relative strength of an ideal timing strategy would not decline over time. FundX RM is inferior to the Nicholas timer for this application because of the

greater decline over time. We have yet to discover a timing strategy which does not show some decline with some portfolios in some market conditions.

The usual alternative, a small momentum portfolio with a static 40% allocation to bonds, would have lost 96% of its value relative to the untimed portfolio over this interval. This corresponds to a 3.6% average annual decline.

Nicholas and FundX RM timing are lower cost strategies by far for insuring against severe drawdowns. That is, Nicholas and FundX RM timing preserve more of the return than a static allocation to bonds.

The historical drawdowns of the small momentum portfolio with and without mitigation are shown in Table 4.

Table 4. Percentage Drawdowns of Small Momentum Portfolios Over Time. Maximum drawdowns in different portfolio seldom occur on the same date and sometimes occur many months apart. The results shown are the maximum percentage drawdowns over the periods indicated.

5 years ending	No Mitigation	40% Bonds	Nicholas Timing	FundX RM Timing
1933	81	59	57	41
1938	65	44	27	27
1943	55	33	54	54
1948	33	21	18	25
1953	22	12	19	26
1958	17	10	8	6
1963	23	14	9	9
1968	28	17	14	23
1973	47	30	36	21
1978	45	27	38	25
1983	21	14	21	21
1988	37	22	33	33
1993	26	15	17	21
1998	28	16	28	15
2003	23	14	23	23
2008	44	27	12	12
2013	54	35	23	23
3 yrs to 2016	18	10	16	14

Source: Monthly Allocations July2017.xlsb

The conclusion from history is that Nicholas timing and FundX RM timing would have limited large drawdowns better than a static allocation to bonds while preserving more of the return.

Level3 Portfolios and Benchmarks

Statistics for Level3-type portfolios are assembled in Table 5. We substituted indices in some cases in order to be able to show adequate histories. The interval spans the full interval for which there is history for the AAII Shadow Stock portfolio, less the one year needed to initialize the FundX RM timer.

Table 5 also includes performance statistics for several benchmarks. These were chosen to represent a range of investment styles. If yours is a conventional portfolio with sixty percent stocks and forty percent bonds, we suggest that you compare the statistics of the Level3 portfolios to the 7.8% return, 0.61 Sharpe ratio and 33% maximum drawdown of the Mellon benchmark.

Sidebar

"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 annualized 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.

"Wins" is the frequency, in percent, with which the 3-year return of the timed portfolio exceeds the 3-year return of the reference portfolio.

If you are a dividend investor, compare the Level3 statistics to the 11.0% return, 69% Sharpe ratio and 44% drawdown of the Dividend Aristocrats®.

If you are a conservative investor, focus on the 8.0% return, 88% Sharpe ratio and 19% drawdown of the Vanguard Wellesley Income fund.

Level3 portfolios generally provide higher returns, generally lower Sharpe ratios and higher drawdowns than your preferred benchmark.

Table 5. Timing Level3 Portfolios and Benchmarks. Entries marked "Portfolio Visualizer" used this software to implement FundX RM timing[26]. Returns for the indices and for the French portfolios are overstated because expense ratios are neglected.

1994 – 2016[27]	CAGR, %	Sharpe	MaxDD, %
Equal Weight Wilshire 5000[28]	13.4	0.59	59
40% bonds	10.7	0.68	39
Nicholas timing	13.4	0.73	29
FundX RM timing, W5000 or bonds	13.1	0.77	21
Portfolio Visualizer. W5000 or bonds	13.1	0.77	21
French Small Cap Value Portfolio[29]	13.6	0.64	60
40% bonds	10.7	0.73	39
Nicholas timing	13.6	0.79	27
FundX RM timing, SmlVal or bonds	13.0	0.77	26
French Small Cap Momentum Portfolio	14.3	0.63	54
40% bonds	11.2	0.71	35
Nicholas timing	14.9	0.73	26
FundX RM timing, SmlMom or bonds	11.3	0.58	23
AQR US Small Cap Momentum Index[30]	10.5	0.46	53
40% bonds	9.0	0.54	34
Nicholas timing	9.4	0.64	20
FundX RM timing, SmlMom or bonds	6.0	0.40	28
Russell MidCap Value (RUM-J[31])	11.4	0.61	57
40% bonds	9.2	0.72	37
Nicholas timing	12.0	0.87	23
FundX RM timing, MidValue or bonds	11.6	0.95	17

[26] For the Portfolio Visualizer backtest of FundX RM timing of VFINX, see goo.gl/Kbt5SX. The authors have no financial interest in this free software.

[27] Although there are Shadow Stock data from 1993, the evaluation interval had to be shortened by one year because FundX RM timing requires one year of history to initialize the algorithm.

[28] No fund tracks the Equal Weight Wilshire 5000 index but RSP and EQAL track equal weight variations of the S&P 500 and Russell 1000 indices. Expense ratios are 0.4 and 0.2% respectively.

[29] Vanguard Small Cap Value Fund (VISCX or VBR), with expenses of 0.19% and data from 1998, is a possible surrogate for this index.

[30] AQR Small Cap Momentum Style Fund (ASMNX) can be purchased in a Fidelity IRA with a $2500 initial investment. The expense ratio is 0.85%.

[31] The iShares Russell Mid Cap Value ETF (ticker IWS) tracks this index. The expense ratio is 0.25%.

Real Estate (FRESX)	10.6	0.48	71
40% bonds	9.0	0.56	48
Nicholas timing	10.7	0.64	28
FundX RM timing, FRESX or bonds	12.09	0.79	17.3
Portfolio Visualizer, FRESX or bonds	12.07	0.78	16.3
AAII Shadow Stocks, 1994-2016	15.4	0.70	63
40% bonds	11.8	0.79	42
Nicholas timing	15.8	0.88	22
FundX RM timing, Shadow or bonds	14.57	0.81	22.03
Portfolio Visualizer, Shadow or bonds[32]	14.56	0.81	22.03
Benchmarks, 1994 – 2016			
S&P 500® Composite (VFINX)	9.1	0.50	51
40% bonds	7.8	0.61	33
Nicholas Timing	11.0	0.81	16
FundX RM timing, VFINX or bonds	11.0	0.85	15
Portfolio Visualizer, VFINX or bonds	11.0	0.85	15
S&P 500® Dividend Aristocrats®[33]	11.0	0.69	44
40% bonds	8.8	0.80	26
Nicholas timing	10.2	0.90	12
FundX RM timing, DivAristo or bonds	10.2	0.90	12
BNY Mellon[34] (40% bonds)	7.8	0.61	33
Nicholas timing	8.7	0.93	8
FundX RM timing, Mellon or bonds	8.2	0.89	10
Wellesley Income (VWINX, 65% bonds)	8.0	0.88	19
Nicholas timing	7.7	1.00	9
FundX RM timing, VWINX or bonds	7.42	1.01	7
Portfolio Visualizer, VWINX or bonds	7.37	1.00	8

Sources: Portfolio Visualizer & SIMPLE.xlsx and Monthly Allocations July2017.xlsx.

[32] Timing Models, Momentum Rotation (Relative Strength), Multiple performance periods (1, 3, 6 and 12 months, 25% weight each), Tickers SVBFX and SHADOW (monthly returns for shadow stocks imported into Portfolio Visualizer). Hold the single asset, shadow stocks or bonds, with the highest average returns over the trailing 1, 3, 6 and 12 months.

[33] ProShares S&P 500 Dividend Aristocrats ETF (NOBL) has tracked this index since October 2013. The expense ratio is 0.35%. ProShares S&P Midcap 400 Dividend Aristocrats ETF (REGL) has tracked the S&P Midcap 400 Dividend Aristocrats Index since February 2015. The expense ratio is 0.40%.

We are grateful to ProShares' Chelsea Sherma for providing the historical data on the underlying index. The index went live in May 2005; prior returns are simulated.

[34] 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, 10% foreign stocks and 40% bonds.

A permanent allocation to 40% bonds would have reduced the drawdowns and returns of the Level3 portfolios. Nicholas and FundX RM timing would have provided larger reductions in the drawdowns with less reduction in the returns.

The agreement with the Portfolio Visualizer FundX RM simulations is excellent. We and Portfolio Visualizer even calculate the Sharpe ratio in the same way.

Level3 portfolios with Nicholas or FundX RM risk control are less risky than the benchmarks in the conventional sense of lower drawdowns. The Level3 portfolios with risk control are also less risky in Cloonan's sense of having more at the end of the accumulation phase.

Nicholas and FundX RM timing would have reduced the drawdowns associated with the benchmark portfolios and would have improved Sharpe ratios.

SIMPLE Portfolio

Antonacci suggests allocating between US and foreign stock funds when the markets are tranquil and substituting an intermediate term bond in times of market stress[35]. We add a real estate fund and an intermediate and a long bond fund to his portfolio and we invest equally in the two funds with the highest FundX momentum. We call this the "SIMPLE portfolio."

It is possible to model the performance of this portfolio over the past 45 years. Statistics over the interval for which we have results for the Shadow stocks are summarized in the following table.

Table 6. SIMPLE Portfolio, 1994 - 2016. Simulations were performed using our software or Portfolio Visualizer (PV)

Sources: Simulations 1 and 3 employ Monthly Allocations July2017.xlsx; simulations 5 and 7 employ MomSim.

	CAGR, %	Sharpe	MaxDD, %
Two of 3 stock funds	10.7	0.59	59
PV: Two of 3 stock funds[36]	10.7	0.59	59
Two of 3 stock funds or 100% bonds	11.2	0.81	16
PV: Two of 3 stock funds or 100% bonds[37]	11.2	0.81	16
Two of 5 stock and bond funds	13.2	0.95	16
PV: Two of 5 stock and bond funds[38]	13.3	0.97	16

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

[36] This simulation is the same as the simulation of the SIMPLE portfolio (goo.gl/Kbt5SX) but without the bond funds.

[37] Import the equity curve of the two of 3 stock funds portfolio into Portfolio Visualizer as a benchmark. Use Portfolio Visualizer to backtest the imported equity curve with FundX RM timing as is illustrated at goo.gl/Kbt5SX.

[38]/ For the Portfolio Visualizer simulation of the SIMPLE portfolio, see goo.gl/yf3wAE.

Two of 5 stock and bond funds, average of FundX, 12MOM and Dema20 allocations	13.9	1.06	14

The first pair of simulations in Table 6 uses the FundX algorithm to allocate to the top 2 of three stock funds (VFINX, HAINX and FRESX.)

The second pair of simulations adds FundX RM timing. When the markets are tranquil, the algorithm invests in two of the stock funds. During bear markets, the portfolio is invested in bonds (VBMFX).

The third pair of simulations uses FundX RM to allocate to the top 2 of five funds (VFINX, HAINX, FRESX, VBMFX and VUSTX). When the markets are tranquil, the portfolio is generally invested in two of the stock funds. When markets are unsettled, the portfolio is generally invested in one of the stock funds and in one of the bond funds. During bear markets, the portfolio is generally invested in the two bond funds.

The final simulation allocates to the top 2 of the five funds based on the average recommendations of the FundX, 12MOM (Antonacci Absolute Momentum) and Dema20 algorithms.

The SIMPLE portfolio provided returns which are competitive with the returns of Level3 portfolios with risk control while the Sharpe ratios and drawdowns are superior. The SIMPLE portfolio presents no liquidity concerns for the individual investor and trading costs are negligible.

A broader survey of the performance of variations on the SIMPLE portfolio over a slightly longer interval appears in Table 7. Portfolio Visualizer can rank securities in terms of the average of the returns over the trailing 1-, 3-, 6- and 12 months or in terms of the average of the ranks over the trailing 1-, 3-, 6- and 12 months. The average of the ranks is a better indicator for this portfolio.

Table 7. SIMPLE Portfolio, 1993- 2016. The first four simulations allocate among VFINX, HAINX and FRESX with VBMFX as the bond alternative. The remaining simulation allocate among VFINX, HAINX, FRESX and two to six bond funds in various combinations. "PV" identifies the simulations which use Portfolio Visualizer.

1993 – 2016	**CAGR, %**	**Sharpe**	**MaxDD, %**
FundX allocation, Top2, no timing	11.1	0.61	59
FundX allocation, Top2, Nicholas timing	12.6	0.94	14
FundX allocation, Top 2, FundX RM timing	11.6	0.84	16
PV: dual momentum[39]	13.5	0.95	19

[39] Timing Models, Dual Momentum, Timing period: 12 months;, Tickers VFINX, HAINX and FRESX; Hold 2 assets; Out of Market Asset: VBMFX; Single Absolute Momentum: NO.

This model allocates to the two equity funds with the highest returns over the trailing 12 months.

Dual Momentum, as created by Antonacci, uses a single absolute momentum filter based on the S&P 500 Composite with dividends. A "No" response to the single Absolute Momentum query does not use the

PV: FundX, Top 2, Sht, Int & Lng bonds[40]	12.2	0.89	16
PV: FundX, Top 2, 2 Sht & 2 Int bonds	12.8	0.95	16
PV: FundX, Top 2, 2 Int & 2 Lng bonds	12.4	0.90	16
PV: FundX, Top 2, 2 Short bonds	12.9	0.96	15
PV: FundX, Top 2, 2 Intermediate bonds	12.8	0.96	16
PV: FundX, Top 2, 2 Long bonds	13.2	0.93	18
PV: FundX Return, Top 2, 1 Sht &, 1 Long	13.8	1.02	16
PV: FundX Rank, Top 2, 1 Sht & 1 Long	14.9	1.16	14
PV: FundX Return, Top 2, 1 Int &, 1 Long	13.6	1.00	16
PV: FundX Rank, Top 2, 1 Int & 1 Long	15.3	1.19	14

Sources: Portfolio Visualizer & SIMPLE.xlsx.

Antonacci method but bases the absolute momentum filter on the individual performance of the securities. This improves the annualized return for this portfolio over this interval.

[40] Short federal (VSGBX), short investment grade corporate (VFSTX), intermediate investment grade (VBMFX and PTTRX), long Treasury (VUSTX) and long investment grade corporate bonds (VWESX).

FundX Tactical Allocation Lengthens Portfolio Longevity

Rotblut describes a fictitious couple, the Pinkertons, who retired at the end of 2007. They panicked during the 2008 bear market, sold near the bottom and locked-in a one third loss when the market recovered.

Table 7. The Pinkerton Portfolios, 1994-2016.

	Current	Adjusted	FundX RM Top 2
US Large Caps	60% VFINX	52.1% VFINX	VFINX
US Small Caps	15% NAESX	10.6% NAESX	NAESX
US REITS	15% FRESX	10.6% FRESX	FRESX
Bonds	5% VBMFX	13.35% VBMFX	VBMFX; VUSTX
Cash	5% VFSTX	13.35% VFSTX	None
CAGR, % per year	9.2	8.3	12.5
Worst Annual Loss, %	33	26	5
Maximum DD, %	49	40	12
Sharpe ratio	0.55	0.58	0.90
Mean, standard deviation	11.6%, 14.3%	10.3%, 11.6%	13.2%, 12.1%
Indicated risk of running out of money, %[41]			
20 years	12	12	2
25 years	20	24	6
30 years	27	34	9

Rotblut increases the allocation to cash and bonds in order to reduce their downside risk[42].

The historical performance of the Pinkerton portfolios was simulated using Portfolio Visualizer[43]. Adjusting the bond allocation would have reduced the worst annual performance over the past twenty-three years, confirming the risk reduction seen by Rotblut.

The Pinkerton portfolio contains three equity funds. We added an intermediate and a long bond fund so that we could apply the same FundX RM allocation

[41] Monte Carlo simulations assuming a 6% annual withdrawal rated adjusted for inflation and mean returns and standard deviations of (11.6%, 14.3%), (10.3%, 11.6%) and (13.2%, 12.1%) for the current, adjusted and FundX RM portfolios. The extended version shows how we estimated these returns and standard deviations. Income tax effects have not been considered. Appendix A contains a screen shot of the Portfolio Visualizer parameters

[42] Rotblut, *op. cit.*

[43] For the Portfolio Visualizer backtest of the current Pinkerton portfolio, see goo.gl/Pu4bxL.

strategy which we employed with the SIMPLE portfolio. Investing each month in the top 2 funds with the highest FundX RM momentum would have reduced the worst annual loss to 5%, reduced the maximum drawdown four-fold and significantly increased the return and Sharpe ratio.

The Pinkertons are drawing $30,000 a year from their portfolio. The Pinkertons have been retired for ten years and could need to draw this amount, adjusted for inflation, for twenty or thirty more years.

The panic sale increased the Pinkerton's withdrawal rate as a fraction of portfolio value from 4% when they retired to about 6% currently. An increased withdrawal rate does not increase the risk of running out of money so long as it is remains below the safe withdrawal rate for the remaining time horizon.

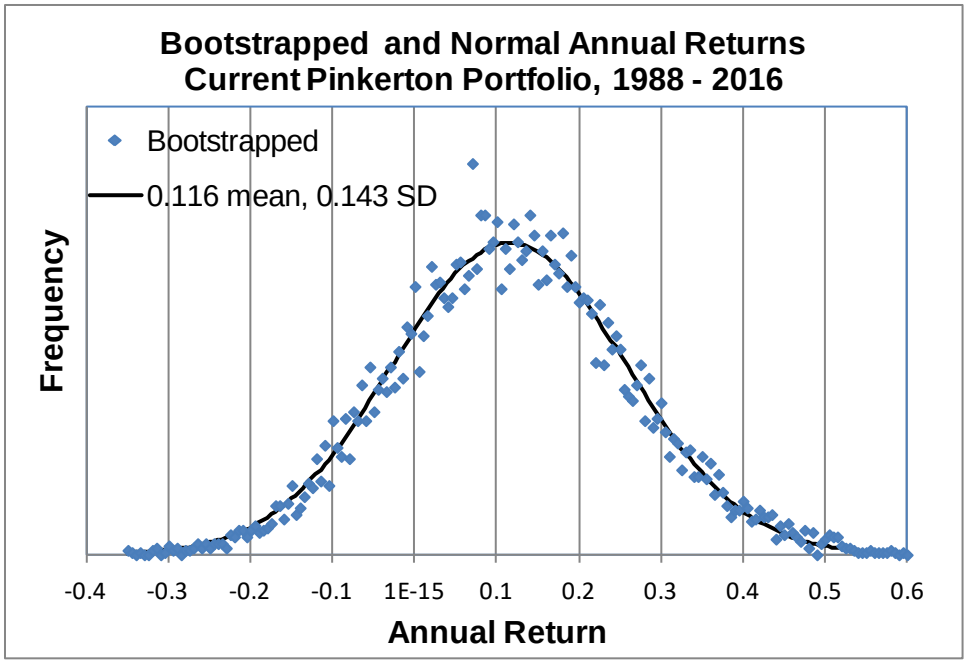
Monte Carlo simulation can be used to estimate portfolio longevity. The approach used within Portfolio Visualizer requires assumptions about the future distribution of portfolio returns.

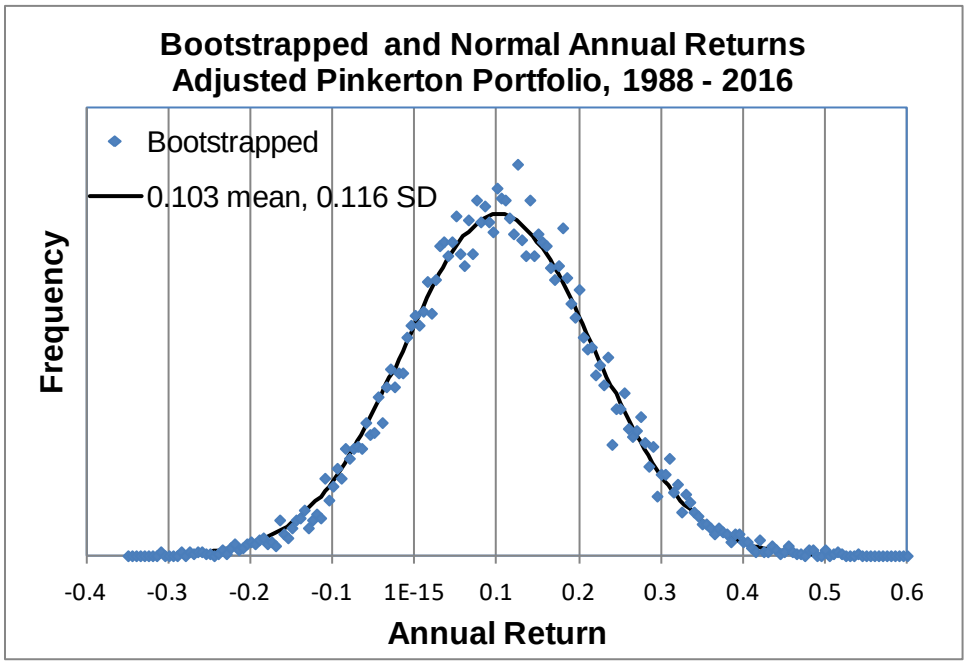
We assumed future monthly returns would be similar to backtested returns during 1988 – 2016. We drew 12 returns (one at a time with replacement) from the backtested monthly returns and calculated an annual return. We repeated the random draw ten thousand times each for the current, adjusted and FundX RM portfolios. In this way, we developed annual return distributions which were consistent with the magnitudes but not the order of the monthly returns. This process is called "bootstrapping."

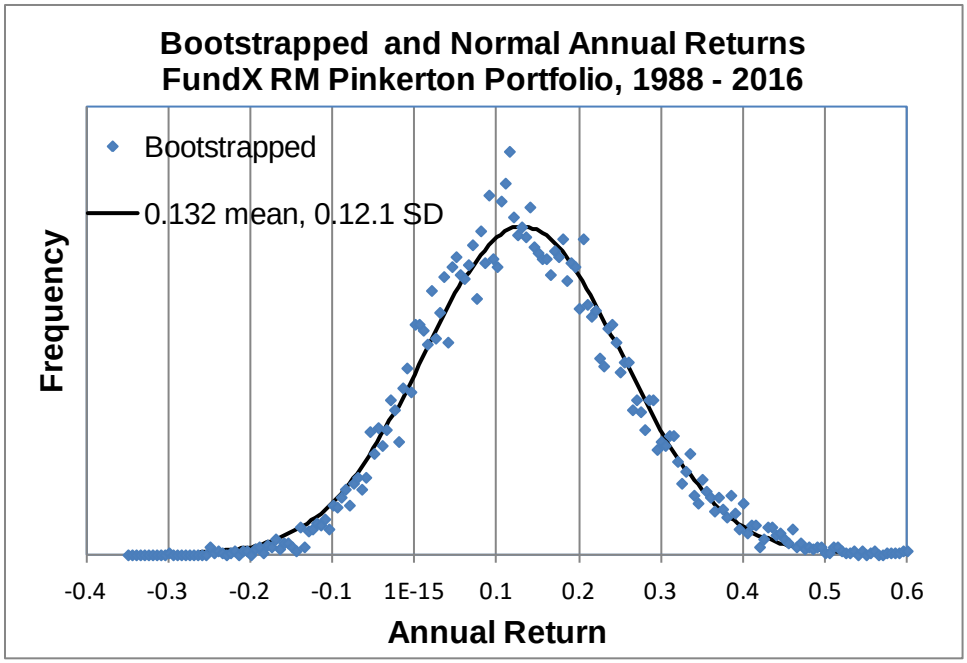
Because of the central limit theorem, bootstrapping tends to produce a normal like distribution. The return distributions are shown below; the solid curves are normal distributions. The means and standard deviations are summarized in Table 7.

The Monte Carlo simulations with these return distributions suggest a 6% withdrawal rate represents a significant risk of running out of money over twenty or thirty years with either the current or adjusted portfolios. The implication is that it would be prudent for the Pinkertons to consider reducing the stress on their portfolio. This means reducing their spending, purchasing a life annuity or managing their portfolio using FundX RM.

As shown in Table 7, managing the Pinkerton's portfolio using FundX RM reduces their risk of running out of money.







In his book, Cloonan emphasizes that the primary focus in portfolio design should be on having enough. Adjusting the cash and bond allocation reduces volatility without appreciably extending the life of the portfolio. FundX RM reduces the volatility while also reducing the risk of running out of money.

Implementation

We used mutual funds rather than ETFs to backtest the performance of the SIMPLE and Pinkerton portfolios because mutual funds have longer histories. It may be more convenient to implement these strategies using ETFs.

A number of funds have been launched to exploit factor investing and we summarize information for some of them here. Since most of these funds have short histories, your choice will generally be based on the historical equity curve of the index rather than on the fund history.

AQR funds generally require large initial investments but can be purchased with lower minimums inside a Fidelity IRA and through select advisers.

Ticker	Adviser	Index or Methodology	Number of Securities	Inception
Momentum Funds				
AMONX	AQR Capital Management	AQR LrgCap Momentum	500±	2009
ASMNX	AQR Capital Management	AQR SmlCap Momentum	750±	2009
MTUM	iShares	MSCI USA Momentum	125±	2013
MOM	QuantShares	Dow Jones U.S. Thematic Market	400±	2011

		Neutral Mom.	long and short	
PDP	PowerShares	DWA Technical Leaders Index	100±	2007
QMOM	Alpha Architect	Alpha Architect Quantitative Momentum Index.	50±	2015
SPMO	PowerShares	S&P 500 Momentum	100±	2017
Value Funds				
DFSVX	Dimensional Fund Advisers	Small Cap Value, actively managed	1000±	1993
IJS	iShares	S&P Small Cap 600 Value	440±	2000
QVAL	Alpha Architect	Alpha Architect Quantitative Value	40±	2014
SPVU	PowerShares	S&P 500 Enhanced Value	100±	2015
VISVX or VBR	Vanguard	CRSP US Small Cap Value Index	830±	1998
VIVAX or VTV	Vanguard	CRSP US Large Cap Value Index,	330±	1992
Value plus Momentum Funds				
SPVM,	PowerShares	S&P 500 High Momentum Value	100±	4/3/2017
VMOT	Alpha Architect	Alpha Architect Value Momentum Trend Index.	A fund of funds	5/2/2017
Quality, Value and Momentum				
QLC	FlexShares	Northern Trust Quality LrgCap^{SM}	130±	2015
Multi-Factor Funds				
CSML	IndexIQ	NASDAQ Chaikin Power Equal Wt US Small Cap[44]	230±	2017
DEEF (Value, Quality, Volatility, Momentum, Size)	Deutsche Asset Management	FTSE Developed ex U.S. Comprehensive Factor Index	1100±	2015
DEMG (Value, Quality, Volatility, Momentum, Size)	Deutsche Asset Management	FTSE Emerging Comprehensive Factor Index	700±	2016

[44] Index has been live from 2014. 17% CAGR and 63% drawdown since 2001 based on backtesting.

DESC (Value, Quality, Volatility, Momentum, Size)	Deutsche Asset Management	Russell 2000 Comprehensive Factor Index	1500±	2016
DEUS (Value, Quality, Volatility, Momentum, Size)	Deutsche Asset Management	Russell 1000 Comprehensive Factor Index	830±	2015
GQRE (Quality, Value, Momentum)	FlexShares	Northern Trust Global Quality RE Index℠	160±	2013
TILT (Small Value)	FlexShares	MStar US Market Factor TILT Index	1900±	2011
QLC (Quality, Value, Momentum)	FlexShares	Northern Trust Quality (US) Large Cap Index℠	130±	2015
Dividend Growth Funds				
NOBL (large cap)	ProShares	S&P 500 Dividend Aristocrats®		2013
REGL (mid cap)	ProShares	S&P 600 Dividend Aristocrats®		2015

Since funds must hold larger stocks so that there is adequate liquidity to support portfolio changes, we do not expect fund returns to be as attractive as the returns of the French small value and small momentum portfolios. For the best factor returns, portfolio management is a do it yourself project. You might use Stock Investor Pro to screen for small value stocks and invest in the half dozen with the best momentum.

Our experience allocating to individual stocks indicates that it is important to limit allocations to, say, one percent of the daily trading volume. If you were to use Stock Investor Pro to identify a concentrated small momentum portfolio, you could find yourself wanting to allocate a hundred thousand dollars to each position. A one percent limit would eliminate stocks which trade less than $10 million daily.

The SIMPLE and Pinkerton portfolios allocate to large funds and are therefore less affected by trading limitations.

Summary and Conclusions

Small value and small momentum portfolios have provided higher returns than US large cap portfolios over long intervals. However, these portfolios can sometimes provide no benefit for decades and have occasionally lost a third of their relative value over a few years. Small value and small momentum investment strategies are more appropriate for patient investors with long time horizons or who are otherwise able to weather periods of underperformance.

All factor portfolios exhibit periods of underperformance. Cyclicality is reduced with multi-factor portfolios. The selective or intersection approach to multi-factor portfolios is generally superior to the fund of funds approach.

Tactical allocation between small value and large cap stocks would have reduced underperformance and allowed investors with shorter time frames to benefit from small value investing. Tactical allocation among single factor indices should be explored.

Small value, small momentum and Level3-type portfolios exhibit larger drawdowns than conventional benchmarks. Level3 portfolios with risk control have drawdowns which are comparable to the drawdowns of the conservative Wellesley Income fund and which are smaller than the drawdown of the benchmarks.

Risk control generally reduces the return but the reductions in return are smaller than the reductions caused by a permanent bond allocation.

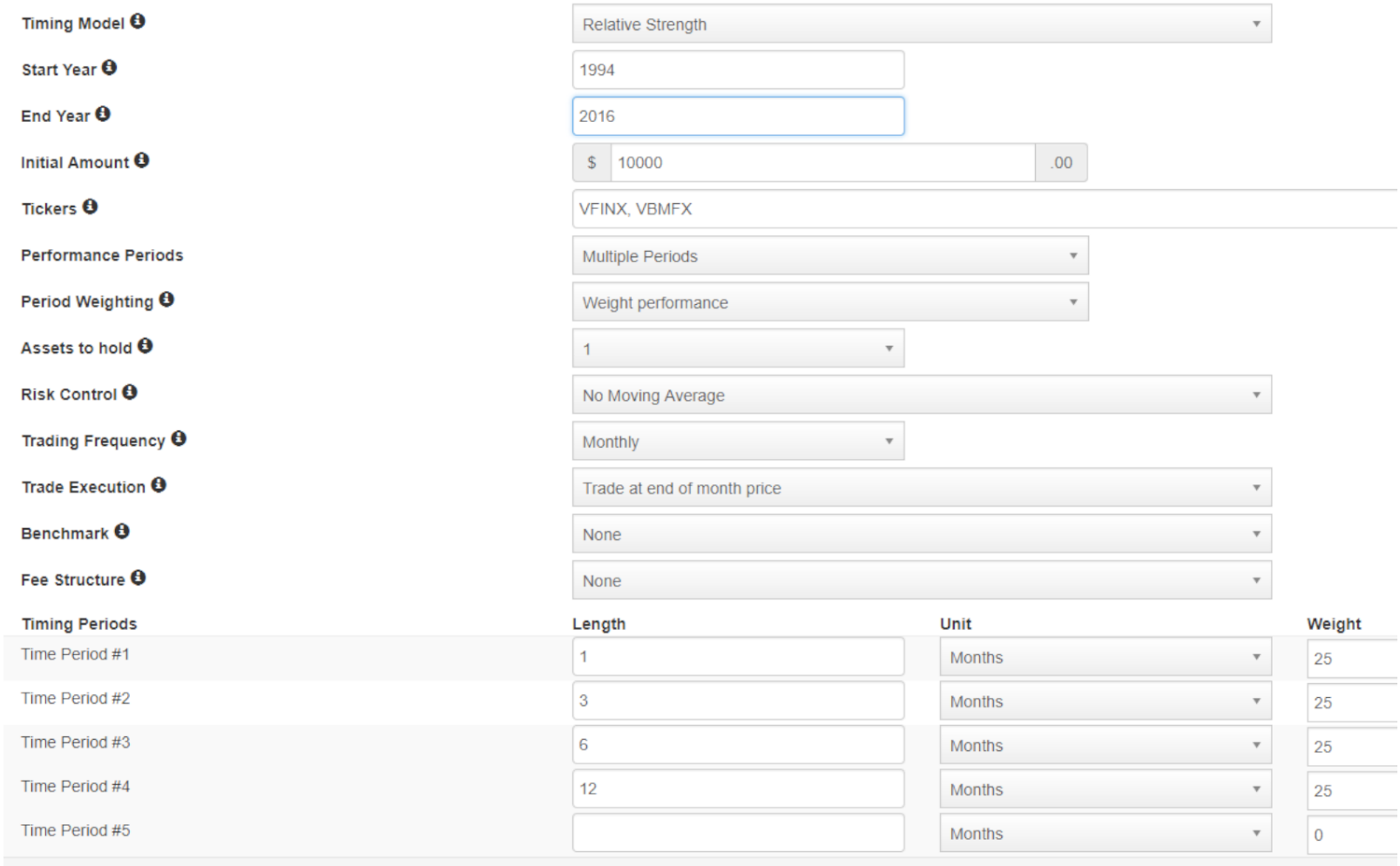
History suggests that the SIMPLE, Pinkerton and Level3 portfolios with risk control are safer than conventional benchmarks because they provide smaller drawdowns and thereby reduce the risk of panic selling. They are also safer because they improve the chances of accumulating enough for retirement and reduce the risk of running out of money.

High return factor-based investing is a do-it-yourself strategy since individual investors are less affected by the capacity issues which plague fund managers.

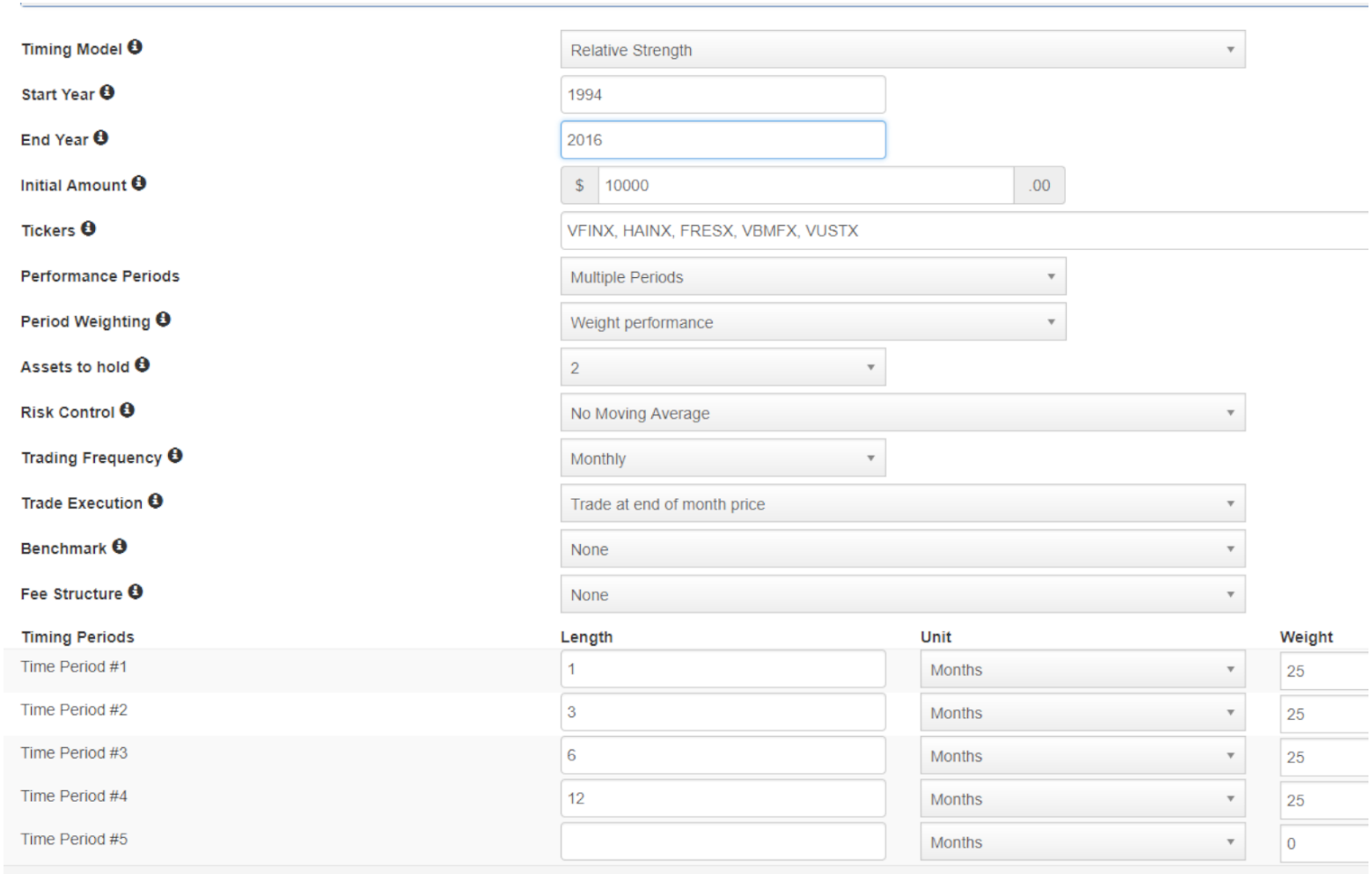
For information on the CIMI Group, see meetup.com/AAII-Silicon-Valley-Meetup/events/240146571/

Appendix A. Screen Shots of the Portfolio Visualizer Parameters

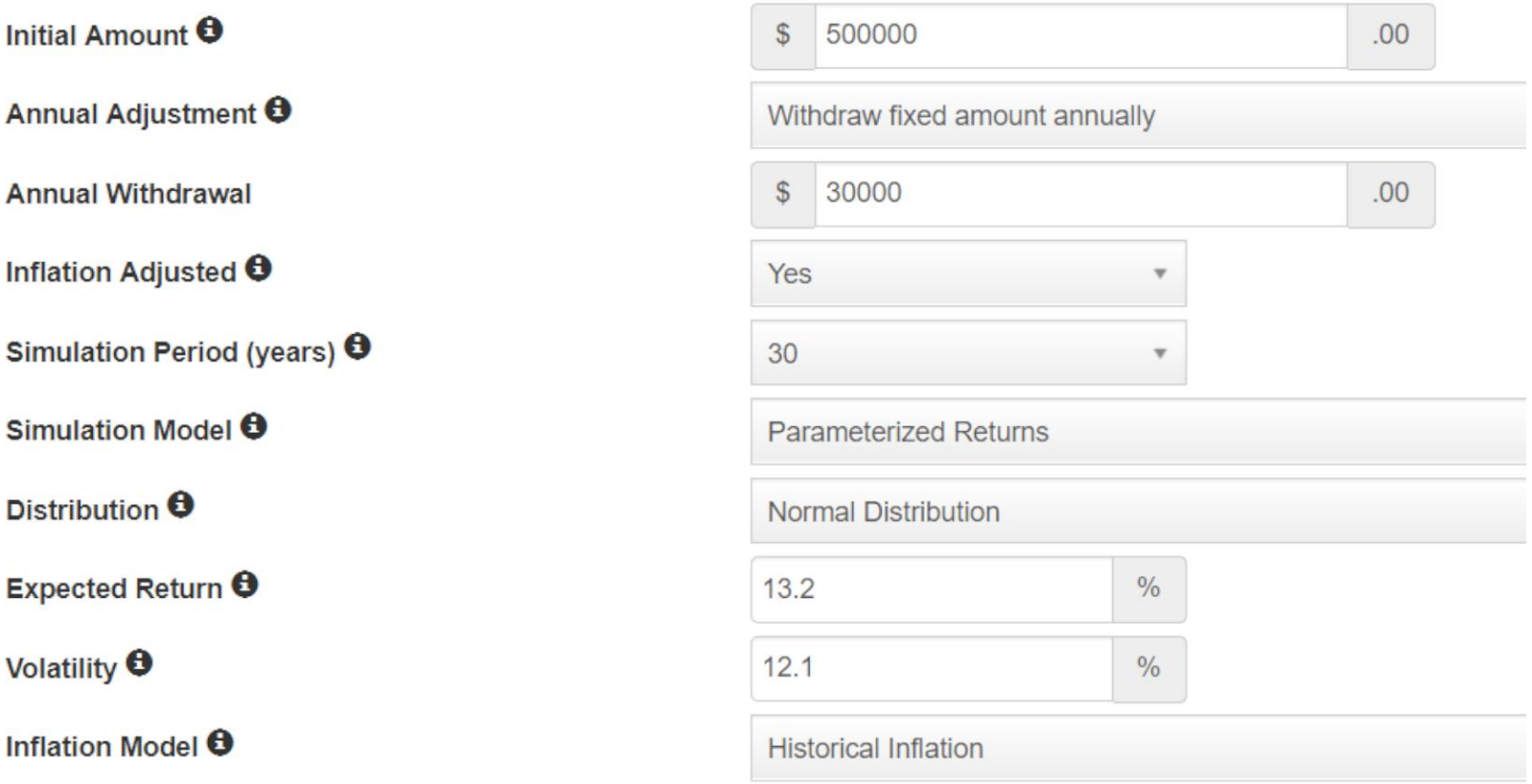
FundX RM Timing. This screen shot illustrates how to use Portfolio Visualizer to time a portfolio of large cap stocks (VFINX) using the FundX RM algorithm. The out of the market or cash position is intermediate term bonds (VBMFX.) This is a timing rather than an allocation application because the portfolio can hold only one asset at a time.



FundX RM Allocation. This screen shot illustrates how to use Portfolio Visualizer to simulate top 2 FundX allocation within a portfolio of stock and bond funds. The SIMPLE portfolio used for this example contains large cap stocks (VFINX), foreign stocks (HAINX) and real estate (FRESX). Intermediate term bonds (VBMFX) and long Treasury bonds (VUSTX) are added to allow the algorithm to allocate to bonds in times of market stress, thereby mitigating downside risk.



Monte Carlo. This screen shot illustrates how to use Portfolio Visualizer to simulate many portfolios in which the annual returns are drawn from a distribution characterized as Normal(0.132,0.121).



Backtest Portfolio Performance. This screen shot illustrates how to use Portfolio Visualizer to simulate the value over time of the Pinkerton portfolio.

The purpose of a backtest simulation is to develop the monthly returns which are used to generate an annual return distribution for Monte Carlo simulation.

Appendix B. The Path Matters: the FIP Approach

Da, Gurun and Warachka[45] show than 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.

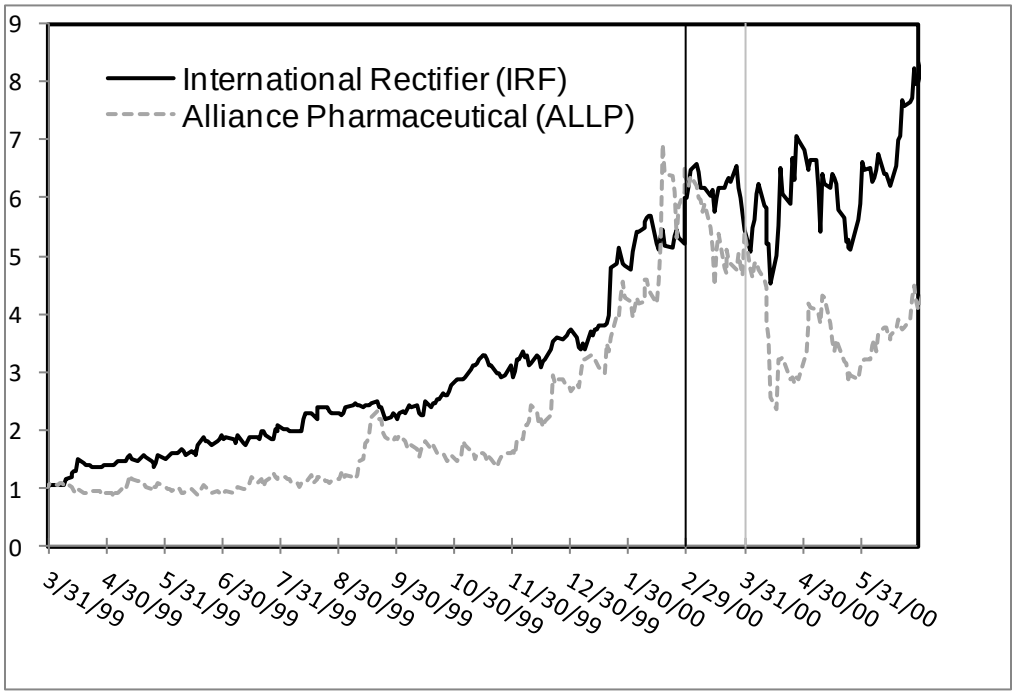
Da, Gurun and Warachka suggest an empirical measure of information discreteness

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

[45] 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 eleven month return (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 signal 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[46] favor IRF.

Kestner's k-ratio[47], suggested to me by Don Maurer, also favors IRF.

Information Discreteness likely does not apply to funds.

It is unclear as to the interval over which ID should be measured; Gray and Vogel appear to measure ID over many years.

It is unclear as to the interval over which "prior return" is measured.

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 who provided the historical data for this analysis.

[46] 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.

[47] thesystematictrader.com/2013/04/22/coding-lars-kestners-k-ratio-in-excel/. See also Lars N. Kestner, "(Re)Introducing the K-Ratio," March 2013, papers.ssrn.com/sol3/papers.cfm?abstract_id=2230949.