# Reliable Timing Algorithms

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**Summary**

A "reliable" investment strategy is defined as providing better short-term returns than the benchmark under most historical market conditions.

The benchmark portfolio for present purposes contains 60% large cap US stocks and 40% intermediate-term Treasury bonds (IGBonds).

Reliable algorithms are likely to be composites of individual algorithms since a composite dampens the tendency of individual algorithms to outperform the benchmark in some months and to underperform in others.

The usual performance metrics, CAGR, Sharpe ratio and the like, measure long-term results and say little about short-term performance against the benchmark. To provide information about short-term reliability, this study examines the allocation between large cap US stocks and IGBonds and between more complex equity portfolios and IGBonds. The following metrics proved useful.

- WINs. which measures the frequency with which the return of the managed portfolio exceeds the benchmark return over rolling 36-month intervals.
- Visual inspection of the relative strength of the managed portfolio versus the benchmark over time.
- Reliability Index.

Accuracy of the allocation recommendations over time and Up and Down Capture ratios over time did not prove useful.

Timing algorithms struggled in the 1968-1998 interval, failing to match benchmark returns in one fifth of the rolling 36-month intervals. In the post-1998 interval, the better algorithms exceeded benchmark returns in nearly every rolling 36-month interval. An implication is that it is prudent to backtest algorithms over an extended interval.

A composite comprising the AbsMom5_1 and IUC algorithms, plus either the DR*VOL or DR*PR*VOL algorithm, are among the most reliable timers in both intervals. These composites also exhibit an excellent CAGR, an excellent Sharpe ratio and a good UPI. Maximum drawdown is middle of the pack, but better than the benchmark.

These algorithms also did well when timing more complex portfolios.

StormGuard® Armor provided exceptional performance in the post-1998 interval. It is unfortunate that we do not know enough about the construction of this timing algorithm to test performance in the earlier, more challenging, interval.

These results apply to the intervals tested. Future results may be different.

## Long-term Statistics

A common assumption is that an investment strategy which provides good results in historical markets will perform better in the future than a strategy which underperforms in historical markets.

Long backtests offer the opportunity to evaluate strategies under more market conditions. Tests could extend for nearly one hundred years since there are monthly data for large cap US stocks and for CASH from 1926. However, algorithmic performance may be fundamentally different after World War II[1].

A hundred-year test interval limits the types of algorithms that can be tested. Some algorithms require daily price data, for example, and daily data for large cap US stocks are not available before 1950. Other algorithms require unemployment data which are only available from 1967.

Any test interval is therefore a compromise between length and timer availability.

The present study addresses performance from 1968 forward, a total of 51.5 years, three bear markets, seven recessions and extended periods of rising and declining interest rates. The portfolio is allocated to large cap US stocks, or other equity portfolio, when the timing algorithm is bullish and to IGBonds (intermediate-term Treasury bonds) when the algorithm is bearish[2].

The timing algorithms had the most difficulty in calendar years 1969, 1973, 1984 and 1990. Even the better managed portfolios underperformed the benchmark with some frequency prior to 1994.

The benchmark should reflect an investor's current strategy so that the investment choice is between the current strategy or a new strategy. This study uses a benchmark of 60% large cap US stocks and 40% IGBonds, which implies that the investment choice is between reducing risk by market timing or by a permanent allocation to bonds.

The first table summarizes long-term performance statistics[3] for large cap US stocks, for the benchmark and for three portfolios in which the allocation between large cap US stocks and IGBonds is determined by a composite timing algorithm[4].

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[1] 7 Valeriy Zakamulin, "A Comprehensive Look at the Empirical Performance of Moving Average Trading Strategies," SSRN-id2677212, revision December 11, 2015.

[2] The historical equity curves for large cap US stocks, foreign stocks, real estate, T-Bills and IGBonds are documented at www.lingane.com/qi.

[3] Statistics were derived from monthly equity curves.

[4] The definition of the timing algorithms can be found at www.lingane.com/qi. Performance statistics for all portfolios are in the appendices.

A composite signal is the equally weighted average of individual signals. 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 generally not binary.

| 1968 – June 2019 | CAGR | Sharpe | UPI | MaxDD ex 1987[5] | WINs |
|---|---|---|---|---|---|
| Large Cap US stocks | 10.0% | 0.41 | 0.41 | 51% | 64% |
| 60:40 Benchmark | 9.0% | 0.48 | 0.72 | 30% | Reference |
| AbsMom5_1 + DR*VOL + IUC | 12.3% | 0.67 | 1.32 | 24% | 84% |
| 200dSMA + DR*VOL | 12.1% | 0.67 | 1.45 | 21% | 78% |
| 200dSMA + AbsMom5_1 + DR*VOL | 12.3% | 0.68 | 1.51 | 19% | 81% |

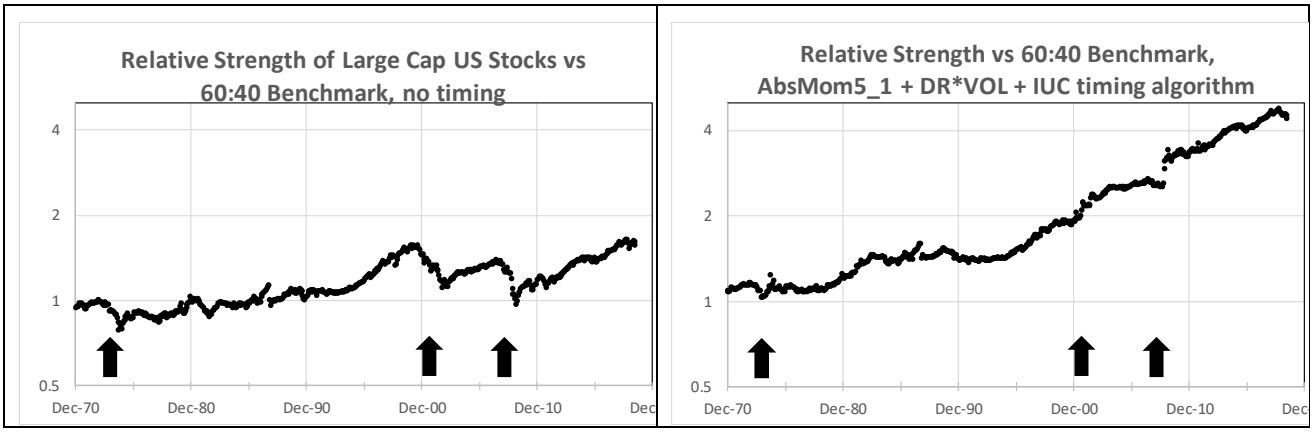
Source: Monthly Allocations Aug 2019.xlsm

The 60:40 benchmark was less volatile than large cap US stock portfolio, as is shown by the higher Sharpe ratio, higher UPI (ulcer performance index) and lower drawdown. The managed portfolios produced higher returns than either large cap US stocks or the benchmark, and lower drawdowns.

**Relative Strength**

Relative strength is the ratio of the value of a managed portfolio to the value of the benchmark. The managed portfolio is outperforming the benchmark when the relative strength is rising over time and underperforming when the relative strength is falling.

The chart below, on the left, is the relative strength of an unmanaged portfolio of large cap US stocks versus the benchmark. The vertical axis is logarithmic, so that declines are more evident, and the arrows locate the 1973-4, 2002-4 and 2008 bear markets.




Source: Monthly Allocations July 2019 rev2.xlsm

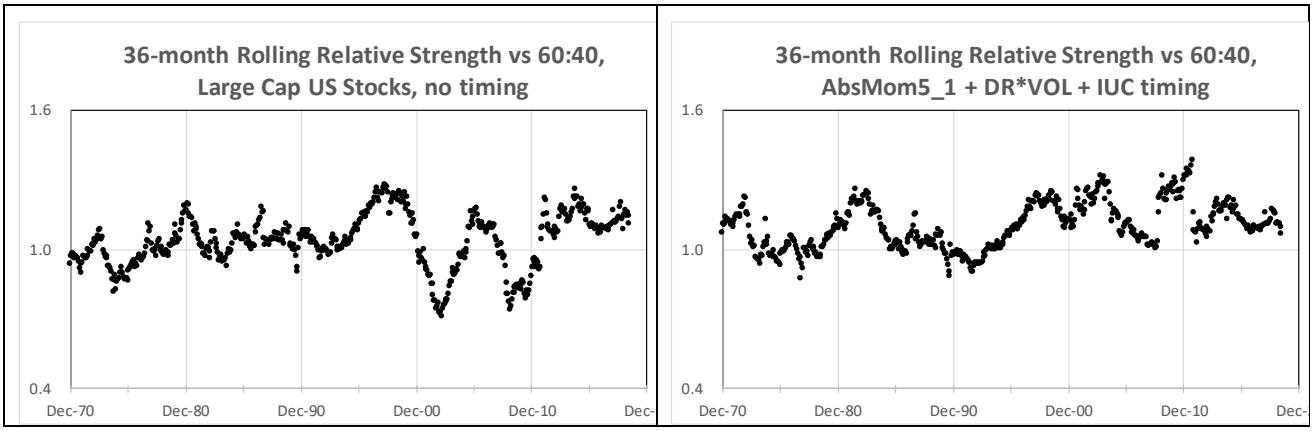
The chart on the right is the relative strength of a portfolio in which the average signal of the AbsMom5_1, DR*VOL and IUC algorithms determines the allocation between large cap US stocks and IGBonds. Bear market declines are less evident with the managed portfolio.

[5] Drawdowns, and recovery, for the July 1987 through June 1988 interval, are uncharacteristically rapid for a bear market and there is little differentiation among the algorithms. Drawdowns for the excluded interval are reported in the appendices.

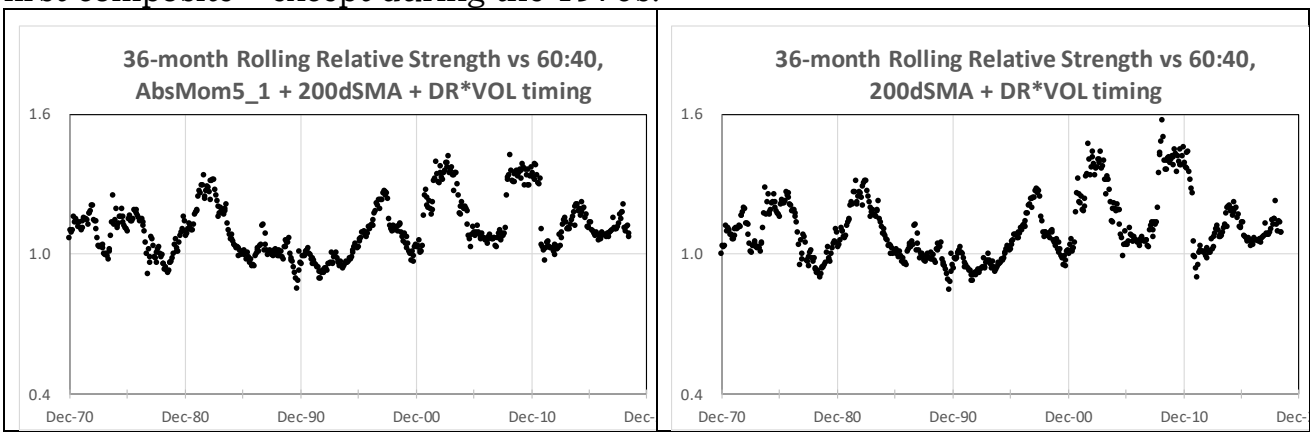
The next charts show the relative strength of the large cap US stocks and the managed portfolio measured over rolling 36-month intervals. The vertical axis is linear.

A portfolio is underperforming the benchmark when the relative strength averages less than 1.0 over the prior 36-months. Over nearly fifty years, large cap US stocks outperformed the benchmark in 64% of the rolling 36-month intervals (WINs in prior table) while the managed portfolio outperformed the benchmark in 84% of the rolling 36-month intervals.

The managed portfolio outperformed the benchmark in all 36-month rolling intervals after November 1993 while large cap US stocks underperformed the benchmark from 2001-2010.




The third set of charts shows the 36-month rolling relative strength for two additional composites. The visual evidence is that the additional composites have a greater tendency to underperform the benchmark – to be less reliable than the first composite – except during the 1970s.




The visual evidence of relative strength over time suggests that the AbsMom5_1A + DR*VOL + IUC composite is an excellent performer.

**Putting a Number on Outperformance**

WINs measures how often the managed portfolio provides a higher return than the benchmark over rolling 36-month intervals. Since 1967, the thirty plus tested algorithms "win" between 63 and 86% of the time over rolling 36-month intervals.

As shown in the prior table, the composites "win" about four-fifths of the time, which is better than most timing algorithms. Compare Appendix A.

**Allocation Accuracy**

A timing algorithm is deemed "accurate" for any month in which the algorithm recommends a partial or full allocation to large cap US stocks and the portfolio return over the following month exceeds the IGBond return. A timing algorithm is also "accurate" when the algorithm recommends IGBonds and the portfolio return over the following month exceeds the return of large cap US stocks.

The next table reports Accuracy averaged over 51.5 years. Differences in accuracy are smaller than differences in UPI.

| 1968 – June 2019 | CAGR | Sharpe | UPI | Average Accuracy | Return ≥ Benchmark | Return ≥ Median |
|---|---|---|---|---|---|---|
| AbsMom5_1 + DR*VOL + IUC | 12.3% | 0.67 | 1.32 | 60% | 75% | 51% |
| 200dSMA + DR*VOL | 12.1% | 0.67 | 1.45 | 60% | 63% | 67% |
| 200dSMA + AbsMom5_1 + DR*VOL | 12.3% | 0.68 | 1.51 | 61% | 61% | 63% |

This table also shows the frequency with which the return of the managed portfolio exceeds the return of the benchmark, measured over calendar years with the 2019 half year counted as a full calendar year. While it is desired that the returns of an investment strategy exceed the benchmark return every calendar year, the results show that calendar year returns of the managed portfolios are often less than the benchmark returns.

The frequency with which a strategy return exceeds the benchmark return is an important metric from a reliability perspective. The AbsMom5_1 + DR*VOL + IUC composite excels.

"Return ≥ Median" measures the frequency with which the calendar year return of a managed portfolio exceeds the median calendar year return of all portfolios managed by individual algorithms[6]. On average, the AbsMom5_1+ DR*VOL + IUC composite provided a return which is about equal to the median return. The other composites provided returns which are higher than the median return.

Maurer and Curry[7] point out that "accuracy" does not distinguish large from small errors. As discussed in Appendix F, the introduction of tolerances does not help the Accuracy metric to distinguish among the composites.

Accuracy over rolling 12-month intervals does not distinguish among the timing algorithms.

[6] Because signals tend to be binary, different algorithms often provide the same monthly return. This produces the curious result that, on average, most algorithms exceed the median return.

[7] E-mail communications, July 5, 2019.

**Capture Ratios**

Curry has suggested UP/DOWN Capture Ratios[8] for assessing algorithm performance. The UP-Capture Ratio is the annualized return of the strategy, counting only the months in which the backtested return is positive, divided by the annualized return of the positive months of the benchmark. The DOWN Capture Ratio is the annualized return of the strategy, counting only the months in which the backtested return is negative, divided by the annualized return of the negative months of the benchmark. The months in which the returns of the strategy are positive, or negative, need not be coincident with the like-signed returns of the benchmark.

As discussed in Appendix F, capture ratios do not provide useful evidence about reliability.

**Reliability Index**

The reliability index, or more properly the "information ratio," measures the skill of a strategy or investment manager. The reliability index is the average monthly return of a strategy minus the average monthly return of the benchmark, divided by the standard deviation of the monthly differences. The ratio is annualized by multiplying by the square root of twelve.

Readers will recognize the reliability index as the Sharpe ratio in which the benchmark return has been substituted for the risk-free return.

The reliability index does differentiate among timing algorithms, as is shown in the following table. The table is ordered by decreasing reliability index.

| 1968 – June 2019 | CAGR | Sharpe | UPI | maxDD ex 1987 | WINs | Return ≥ Benchmark | Reliability Index |
|---|---|---|---|---|---|---|---|
| **60:40 Benchmark** | 9.0% | 0.48 | 0.72 | 30% | Ref. | Ref. | Ref. |
| AbsMom5_1 + DR*Price*Vol + IUC | 12.29% | 0.670 | 1.30 | 24.5% | 83.5% | 74.5% | 0.549 |
| AbsMom5_1 + DR*Vol + IUC | 12.26% | 0.671 | 1.32 | 23.9% | 83.7% | 74.5% | 0.544 |
| SPVOL + DR*Vol + IUC | 11.5% | 0.59 | 0.99 | 24% | 83% | 71% | 0.50 |
| AbsMom5_1 + DR*Vol | 12.3% | 0.67 | 1.37 | 29% | 86% | 65% | 0.49 |
| AbsMom5_1 | 12.5% | 0.64 | 1.28 | 21% | 82% | 71% | 0.48 |
| SWAG + DR*Vol + IUC | 12.0% | 0.66 | 1.32 | 24% | 82% | 71% | 0.48 |
| Modified StormGuard Std + DR*Vol + IUC | 12.1% | 0.66 | 1.28 | 22% | 84% | 71% | 0.48 |
| 200dSMA + AbsMom5_1 + DR*VOL | 12.3% | 0.68 | 1.51 | 23% | 81% | 61% | 0.47 |

[8] www.styleadvisor.com/resources/statfacts/updown-capture. Kudos to Ren Curry for pointing me to this reference.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10mSMA + DR*Vol + IUC | 11.9% | 0.65 | 1.25 | 19% | 81% | 69% | 0.45 |
| IUC | 11.9% | 0.59 | 0.95 | 23% | 79% | 67% | 0.41 |
| 200dSMA + DR*VOL | 12.1% | 0.67 | 1.45 | 30% | 78% | 63% | 0.41 |
| **LrgCapUS** | 10.0% | 0.41 | 0.41 | 51% | 64% | 63% | 0.26 |

The SPVOL + DR*VOL + IUC composite illustrates that a strategy can be reliable (high WIN frequency, high frequency of exceeding the benchmark return and a high reliability index) while delivering relatively poor long-term statistics.

The 200dSMA + DR*VOL composite illustrates that a strategy can have relatively good long-term statistics while being less reliable than other algorithms.

The DR*PR*VOL algorithm, created by Don Maurer, provides similar results to those of the DR*Vol algorithm[9].

**1968 – 1998 Interval**

The backtested history was divided into two subintervals at the suggestion of Ren Curry and performance was tested in both subintervals. The performance of the five algorithms with the highest reliability indices over the first thirty years is shown in the next table. The performance of the five algorithms with the highest reliability indices over the subsequent 21.5 years is shown in the next section.

| 1968 – 1998 | CAGR | Sharpe | UPI | maxDD ex 1987 | WINs | Return ≥ Benchmark | Reliability Index |
|---|---|---|---|---|---|---|---|
| **60:40 Benchmark** | 11.3% | 0.47 | 0.94 | 26% | Ref. | Ref. | Ref. |
| AbsMom5_1 + DR*Vol + IUC | 13.4% | 0.56 | 0.99 | 24% | 72% | 71% | 0.40 |
| AbsMom5_1 | 14.0% | 0.58 | 1.17 | 20% | 71% | 68% | 0.40 |
| AAII (2-1-1-1) | 13.9% | 0.56 | 1.01 | 23% | 77% | 68% | 0.39 |
| AbsMom5_1 + DR*Price*Vol + IUC | 13.3% | 0.55 | 0.95 | 25% | 72% | 71% | 0.39 |
| SPVOL + DR*Vol + IUC | 12.9% | 0.50 | 0.80 | 29% | 72% | 65% | 0.37 |
| **LrgCapUS** | 12.6% | 0.43 | 0.64 | 43% | 66% | 65% | 0.32 |

The timing algorithms struggled in this interval. The return, Sharpe ratio and UPI statistics are only slightly better than the benchmark. The timing portfolios provided a higher return than the benchmark in only about three fourths of the 36-month intervals and the reliability index is an unimpressive 0.4.

[9] Maurer's algorithm is defined as DEMA50 of Daily Return*Daily Price*Daily Volume divided by DEMA50 of Daily Price*Daily Volume.

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

**1999 – June 2019 Interval**

Five additional algorithms can be tested in the post-1998 segment: the StormGuard Armor, Market Momentum and Value Sentiment indicators, Zmyslowski's NASDAQ HiLo timer and the synthetic MSI Russell 3000 timer.

| 1999 – June 2019 | CAGR | Sharpe | UPI | maxDD | WINs | Return ≥ Benchmark | Reliability Index |
|---|---|---|---|---|---|---|---|
| **60:40 Benchmark** | **5.7%** | **0.50** | **0.54** | **30%** | **Ref.** | **Ref.** | **Ref.** |
| StormGuard Armor | 13.5% | 1.27 | 5.58 | 8% | 100% | 100% | 0.85 |
| AbsMom5_1 + DR*PR*VOL + IUC | 10.7% | 0.91 | 2.45 | 12% | 100% | 80% | 0.77 |
| AbsMom5_1 + DR*VOL + IUC | 10.5% | 0.90 | 2.39 | 12% | 100% | 80% | 0.74 |
| AbsMom5_1 + DR*VOL | 10.7% | 0.94 | 2.63 | 11% | 100% | 75% | 0.69 |
| SPVOL + DR*VOL + IUC | 9.5% | 0.79 | 1.43 | 18% | 99% | 80% | 0.69 |
| **LrgCapUS** | **6.2%** | **0.37** | **0.26** | **51%** | **60%** | **60%** | **0.16** |

Many timed portfolios provided a substantially higher return than large cap US stocks over this interval. The more reliable timing algorithms provided high Sharpe and UPI statistics, low drawdowns, nearly perfect WINs and high frequencies of higher annual returns than the annual return of the benchmark.

John Nicholas was fond of referring to recent history as the golden age of timing algorithms. The contrast of recent history with the first thirty years is indeed stark.

The performance of StormGuard Armor is exceptional in this interval.

The relative performance of a timing algorithm can be substantially different over time. For example, the AAII timing algorithm ranked #5 in the first interval; it ranked #28 in this interval.

**SIMPLE Strategy**

The SIMPLE strategy uses the Ensemble algorithm to allocate to the top2 trending funds among US and foreign stocks and real estate[10]. The allocation is to IGBonds when the timing algorithm is bearish.

The Ensemble algorithm ranks fund trends as the average of the FundX and DEMA20 rankings. This is illustrated by the following example.

| | FundX Ranking | DEMA20 Ranking | Average Ranking | Ensemble Ranking |
|---|---|---|---|---|
| Fund A | 1 | 3 | 2.0 | 2 |
| Fund B | 2 | 1 | 1.5 | 1 |
| Fund C | 3 | 2 | 2.5 | 3 |

[10] See "The SIMPLE Investment Strategy" at www.lingane.com/qi.

The five strategies with the highest reliability indices for the 1999 – June 2019 interval are shown in the next table. Details are in Appendix D.

| SIMPLE, 1999 – June 2019 | CAGR | Sharpe | UPI | MaxDD | WINs | Reliability Index |
|---|---|---|---|---|---|---|
| **60:40 Benchmark** | **5.7%** | **0.50** | **0.54** | **30%** | **reference** | **reference** |
| SG Armor | 16.0% | 1.45 | 6.73 | 9% | 100% | 1.00 |
| AbsMom5_1+DR*PR*VOL+IUC | 13.4% | 1.13 | 2.93 | 14% | 100% | 0.92 |
| AbsMom5_1+DR*VOL+IUC | 13.2% | 1.12 | 2.87 | 14% | 100% | 0.89 |
| SWAG+DR*VOL+IUC | 13.1% | 1.15 | 3.55 | 12% | 100% | 0.83 |
| SPVOL | 12.7% | 0.88 | 1.74 | 21% | 100% | 0.82 |

The two DR*VOL composites provide good results with the SIMPLE strategy.

Although the portfolio managed by the SPVOL timing algorithm has a perfect WINs statistic and a relatively high reliability index, other statistics are disappointing.

**Allocating Among Twenty-Seven Fidelity Select Funds.**

There are twenty-seven Fidelity Select funds which focus on a narrow US market sector; see Appendix H. The Ensemble algorithm is used to identify the top3 trending funds and allocation is to IGBOND when the timing algorithm is bearish. The five strategies with the highest reliability indices are shown in the following table.

| 1999 – June 2019 | CAGR | Sharpe | UPI | MaxDD | WINs | Reliability Index |
|---|---|---|---|---|---|---|
| **60:40 Benchmark** | **5.7%** | **0.50** | **0.54** | **30%** | **reference** | **reference** |
| StormGuard Armor | 19.9% | 1.08 | 4.16 | 23% | 100% | 0.85 |
| SWAG | 19.0% | 1.02 | 3.61 | 18% | 98% | 0.80 |
| AbsMom5_1+DR*PR*VOL+IUC | 18.1% | 0.95 | 3.16 | 22% | 100% | 0.79 |
| SWAG+DR*VOL+IUC | 18.1% | 0.97 | 3.50 | 21% | 100% | 0.78 |
| AbsMom5_1+DR*VOL+IUC | 17.9% | 0.94 | 3.09 | 22% | 100% | 0.78 |

These algorithms produce a three-fold increase in annualized return and a modest decrease in maximum drawdown as compared to the benchmark. Full results are in Appendix E.

Although the returns are higher than those shown for the SIMPLE strategy, the Sharpe ratio, UPI and drawdown statistics are less attractive because the Fidelity Select portfolios are more volatile.

The two DR*VOL composites provide good results with the Fidelity Select strategy.

**Including Bonds Among the Investment Options**

If trend identification works, if it is possible to identify the better trending securities, then it should be possible to add bonds to the investment choices and allow the allocation algorithm to move the portfolio to bonds in times of equity stress.

To test this approach, six bond funds were added to the LrgCapUS, SIMPLE and Sector Fund strategies. The allocation algorithm chooses the best trending fund

from among seven choices in the first instance, the top2 funds from nine choices in the second instance and the top3 funds from thirty-three choices in the third instance. There is no market timing.

For the LrgCapUS portfolio, adding bonds without market timing increases the return above that of the untimed portfolio and provides a lower drawdown than the 60:40 benchmark. However, WINs and reliability index are not improved over the untimed portfolio. Ensemble allocation with market timing but without bonds provides the best results of all.

| LrgCapUS, 1999 – June 2019 | CAGR | Sharpe | UPI | maxDD | WINs | Reliability Index |
|---|---|---|---|---|---|---|
| **60:40 Benchmark** | **5.7%** | **0.50** | **0.54** | **30%** | **reference** | **reference** |
| StormGuard Armor timing | 13.5% | 1.27 | 5.58 | 8% | 100% | 0.85 |
| AbsMom5_1 + DR*PR*VOL + IUC timing | 10.7% | 0.91 | 2.45 | 12% | 100% | 0.77 |
| Plus bonds, FundX allocation | 7.4% | 0.56 | 1.00 | 22% | 66% | 0.16 |
| Plus bonds, DEMA20 allocation | 6.9% | 0.52 | 0.81 | 19% | 56% | 0.12 |
| Plus bonds, Ensemble allocation | 6.9% | 0.55 | 1.00 | 17% | 62% | 0.11 |
| LrgCapUS, no timing | 6.2% | 0.37 | 0.26 | 51% | 60% | 0.16 |

For the SIMPLE strategy, adding bonds without market timing increases the return above that of the untimed portfolio and provides a lower drawdown than the 60:40 benchmark. FundX allocation provides the best results. However, Ensemble allocation with market timing but without bonds provides the best results of all.

| SIMPLE, 1999 – June 2019 | CAGR | Sharpe | UPI | MaxDD | WINs | Reliability Index |
|---|---|---|---|---|---|---|
| **60:40 Benchmark** | **5.7%** | **0.50** | **0.54** | **30%** | **reference** | **reference** |
| SG Armor timing | 16.0% | 1.45 | 6.73 | 9% | 100% | 1.00 |
| AbsMom5_1+DR*PR*VOL+IUC timing | 13.4% | 1.13 | 2.93 | 14% | 100% | 0.92 |
| Plus bonds, FundX allocation | 11.3% | 0.94 | 6.73 | 17% | 78% | 0.53 |
| Plus bonds, DEMA20 allocation | 10.3% | 0.77 | 2.93 | 26% | 92% | 0.45 |
| Plus bonds, Ensemble allocation | 10.0% | 0.85 | 3.55 | 14% | 88% | 0.40 |
| SIMPLE, no timing | **9.3%** | **0.54** | **2.87** | **62%** | **82%** | **0.45** |

For the twenty-seven Fidelity Select funds, adding bonds with Ensemble allocation increases the return above that of the untimed portfolio and provides a lower drawdown than the 60:40 benchmark. However, Ensemble allocation with market timing but without bonds provides a better result.

| 27 Funds, 1999 – June 2019 | CAGR | Sharpe | UPI | MaxDD | WINs | Reliability Index |
|---|---|---|---|---|---|---|
| **60:40 Benchmark** | **5.7%** | **0.50** | **0.54** | **30%** | **reference** | **reference** |
| StormGuard Armor timing | 19.9% | 1.08 | 4.16 | 23% | 100% | 0.85 |
| SWAG timing | 19.0% | 1.02 | 3.61 | 18% | 98% | 0.80 |
| Plus bonds, FundX allocation | 12.2% | 0.60 | 0.63 | 39% | 85% | 0.43 |
| Plus bonds, DEMA20 allocation | 14.9% | 0.72 | 1.27 | 37% | 86% | 0.58 |
| Plus bonds, Ensemble allocation | 14.8% | 0.73 | 1.47 | 26% | 97% | 0.57 |
| 27 Select Funds, no timing | 14.0% | 0.65 | 0.97 | 53% | 86% | 0.55 |

**Conclusions**

A “reliable” timing strategy exhibits good long-term statistics, a high frequency of exceeding the benchmark return and a high reliability index.

Timing algorithms struggled before the mid-1990s. Managed portfolios failed to match benchmark returns in one fifth of the rolling 36-month intervals.

In contract, the algorithms did well in the post-1998 interval. It is prudent therefore to test algorithms prior to the mid-1990s.

Equally weighted composites comprising the AbsMom5_1and IUC algorithms, plus either the DR*VOL or DR*PR*VOL algorithms, exhibited a relatively high CAGR, Sharpe ratio, UPI and reliability index over both subintervals.

These timing algorithms also performed well with the SIMPLE and Fidelity Select strategies.

StormGuard® Armor provided exceptional performance in the post-1998 interval. It is unfortunate that we do not know enough about the construction of this composite timer to test performance in the earlier, more challenging, interval.

Adding bonds to the allocation options without timing improves the return of the untimed portfolio and provides a lower drawdown than the benchmark. However, Ensemble allocation with timing but without added bonds provides the best results of all.

**Appendix A. Observations, 1968 – June 2019.** Statistics are determined from the monthly equity curve. Algorithms are ranked by the descending value of the Reliability Index. WLIg+ signals, which begin on April 30, 1969, were prefaced with sixteen months of IUC signals. Source: Monthly Allocations Aug 2019.xlsm, workbook Accuracy.

| Dec 31 1967 – Jun 28 2019 | CAGR | Sharpe | UPI | MaxDD ex 1987 | MaxDD 1987 | WINs | Accuracy, no tolerance | Return ≥ Benchmark | Reliability Index | Switches per year |
|---|---|---|---|---|---|---|---|---|---|---|
| **60:40 Benchmark** | 9.0% | 0.48 | 0.72 | 30% | 17% | reference | | reference | reference | rebalance monthly |
| AbsMom5_1 + DR*PR*Vol + IUC | 12.29% | 0.670 | 1.30 | 24.5% | 25% | 83.5% | 59% | 74.5% | 0.549 | 3.8 |
| AbsMom5_1 + DR*Vol + IUC | 12.26% | 0.671 | 1.32 | 23.9% | 25% | 83.7% | 60% | 74.5% | 0.544 | 3.7 |
| SPVOL + DR*Vol + IUC | 11.5% | 0.59 | 0.99 | 29% | 25% | 83% | 57% | 71% | 0.50 | 4.7 |
| AbsMom5_1 + DR*Vol | 12.3% | 0.67 | 1.37 | 21% | 23% | 86% | 61% | 65% | 0.49 | 2.9 |
| AbsMom5_1 | 12.5% | 0.64 | 1.28 | 24% | 23% | 82% | 61% | 71% | 0.48 | 2.5 |
| SWAG + DR*Vol + IUC | 12.0% | 0.66 | 1.32 | 22% | 25% | 82% | 60% | 71% | 0.48 | 3.4 |
| Modified StormGuard Std + DR*Vol + IUC | 12.1% | 0.66 | 1.28 | 23% | 25% | 84% | 60% | 71% | 0.48 | 2.7 |
| 200dSMA + AbsMom5_1 + DR*VOL | 12.3% | 0.68 | 1.51 | 19% | 23% | 81% | 61% | 61% | 0.47 | 3.3 |
| 10mSMA + DR*Vol + IUC | 11.9% | 0.65 | 1.25 | 23% | 25% | 81% | 60% | 69% | 0.45 | 2.9 |
| IUC | 11.9% | 0.59 | 0.95 | 30% | 30% | 79% | 58% | 67% | 0.41 | 1.3 |
| 200dSMA + DR*Vol | 12.1% | 0.67 | 1.45 | 21% | 23% | 78% | 60% | 63% | 0.41 | 2.1 |
| DR*Price*Vol | 12.1% | 0.64 | 1.15 | 24% | 23% | 80% | 58% | 67% | 0.41 | 1.0 |
| DR*Vol | 12.1% | 0.64 | 1.22 | 22% | 23% | 82% | 58% | 65% | 0.40 | 1.0 |
| 200dSMA | 12.1% | 0.67 | 1.50 | 21% | 23% | 73% | 58% | 67% | 0.38 | 1.4 |
| Modified StormGuard Std | 11.9% | 0.63 | 1.23 | 19% | 23% | 78% | 60% | 67% | 0.38 | 1.2 |
| AAII (2-1-1-1) | 11.8% | 0.61 | 1.14 | 23% | 23% | 79% | 59% | 65% | 0.37 | 1.6 |
| SWAG (1-2-2-0) | 11.8% | 0.63 | 1.28 | 20% | 23% | 72% | 58% | 65% | 0.36 | 2.0 |
| 5AbsMom | 11.7% | 0.64 | 1.35 | 17% | 23% | 71% | 58% | 59% | 0.34 | 1.7 |

| Nicholas (1-1-1-1) | 11.5% | 0.59 | 1.07 | 23% | 23% | 76% | 58% | 61% | 0.34 | 1.3 |
|---|---|---|---|---|---|---|---|---|---|---|
| EMA Golden Cross | 11.6% | 0.61 | 1.16 | 22% | 23% | 70% | 57% | 63% | 0.34 | 0.9 |
| AbsMom | 11.5% | 0.60 | 1.10 | 26% | 30% | 74% | 57% | 63% | 0.33 | 0.9 |
| StormGuard Standard | 11.2% | 0.56 | 0.90 | 24% | 30% | 73% | 59% | 65% | 0.32 | 0.8 |
| 12mMOM | 11.2% | 0.56 | 0.94 | 25% | 30% | 73% | 58% | 65% | 0.31 | 0.7 |
| 10mSMA | 11.3% | 0.59 | 1.10 | 21% | 23% | 69% | 58% | 61% | 0.31 | 1.3 |
| GOOD | 11.2% | 0.55 | 0.90 | 29% | 30% | 73% | 57% | 61% | 0.31 | 0.7 |
| 200dEMA | 11.3% | 0.60 | 1.18 | 21% | 23% | 68% | 57% | 57% | 0.30 | 1.6 |
| SPVOL | 10.2% | 0.45 | 0.50 | 39% | 24% | 69% | 57% | 63% | 0.30 | 3.4 |
| WLIg+ | 11.1% | 0.55 | 1.02 | 28% | 30% | 70% | 56% | 65% | 0.30 | 0.6 |
| Golden Cross | 11.3% | 0.60 | 1.07 | 28% | 30% | 66% | 57% | 61% | 0.29 | 1.0 |
| **LrgCapUS** | 10.0% | 0.41 | 0.41 | 51% | 30% | 64% | | 63% | 0.26 | None |
| MiniDipper | 10.9% | 0.56 | 0.91 | 29% | 30% | 63% | 56% | 59% | 0.26 | 1.1 |
| VAA (12-4-2-1) | 10.3% | 0.50 | 0.85 | 19% | 23% | 64% | 58% | 55% | 0.18 | 3.0 |
| 1968 – June 2019 | CAGR | Sharpe | UPI | MaxDD ex 1987 | MaxDD 1987 | WINs | Accuracy, no tolerance | Return ≥ Benchmark | Reliability Index | Switches per year |

**Appendix B. Observations, 1968 – 1998.** Statistics are determined from the monthly equity curve. Algorithms are ranked by the descending value of the Reliability Index. WLIg+ signals, which begin on April 30, 1969, were prefaced with sixteen months of IUC signals. Source: Monthly Allocations Aug 2019.xlsm, workbook Accuracy.

| **Dec 31, 1967 – Dec 31, 1998** | CAGR | Sharpe | UPI | MaxDD ex 1987 | MaxDD 1987 | WINs | Accuracy, no tolerance | Return ≥ Benchmark | Reliability Index | Switches per year |
|---|---|---|---|---|---|---|---|---|---|---|
| **60:40 Benchmark** | 9.0% | 0.48 | 0.72 | 30% | 17% | reference | | reference | reference | |
| AbsMom5_1 + DR*PR*Vol + IUC | 12.29% | 0.670 | 1.30 | 24.5% | 25% | 83.5% | 59% | 74.5% | 0.549 | 3.8 |
| AbsMom5_1 + DR*Vol + IUC | 12.26% | 0.671 | 1.32 | 23.9% | 25% | 83.7% | 60% | 74.5% | 0.544 | 3.7 |
| SPVOL + DR*Vol + IUC | 11.5% | 0.59 | 0.99 | 29% | 25% | 83% | 57% | 71% | 0.50 | 4.7 |
| AbsMom5_1 + DR*Vol | 12.3% | 0.67 | 1.37 | 21% | 23% | 86% | 61% | 65% | 0.49 | 2.9 |
| AbsMom5_1 | 12.5% | 0.64 | 1.28 | 24% | 23% | 82% | 61% | 71% | 0.48 | 2.5 |
| SWAG + DR*Vol + IUC | 12.0% | 0.66 | 1.32 | 22% | 25% | 82% | 60% | 71% | 0.48 | 3.4 |
| Modified StormGuard Std + DR*Vol + IUC | 12.1% | 0.66 | 1.28 | 23% | 25% | 84% | 60% | 71% | 0.48 | 2.7 |
| 200dSMA + AbsMom5_1 + DR*VOL | 12.3% | 0.68 | 1.51 | 19% | 23% | 81% | 61% | 61% | 0.47 | 3.3 |
| 10mSMA + DR*Vol + IUC | 11.9% | 0.65 | 1.25 | 23% | 25% | 81% | 60% | 69% | 0.45 | 2.9 |
| IUC | 11.9% | 0.59 | 0.95 | 30% | 30% | 79% | 58% | 67% | 0.41 | 1.3 |
| 200dSMA + DR*Vol | 12.1% | 0.67 | 1.45 | 21% | 23% | 78% | 60% | 63% | 0.41 | 2.1 |
| DR*Price*Vol | 12.1% | 0.64 | 1.15 | 24% | 23% | 80% | 58% | 67% | 0.41 | 1.0 |
| DR*Vol | 12.1% | 0.64 | 1.22 | 22% | 23% | 82% | 58% | 65% | 0.40 | 1.0 |
| 200dSMA | 12.1% | 0.67 | 1.50 | 21% | 23% | 73% | 58% | 67% | 0.38 | 1.4 |
| Modified StormGuard Std | 11.9% | 0.63 | 1.23 | 19% | 23% | 78% | 60% | 67% | 0.38 | 1.2 |
| AAII (2-1-1-1) | 11.8% | 0.61 | 1.14 | 23% | 23% | 79% | 59% | 65% | 0.37 | 1.6 |
| SWAG (1-2-2-0) | 11.8% | 0.63 | 1.28 | 20% | 23% | 72% | 58% | 65% | 0.36 | 2.0 |
| 5AbsMom | 11.7% | 0.64 | 1.35 | 17% | 23% | 71% | 58% | 59% | 0.34 | 1.7 |
| Nicholas (1-1-1-1) | 11.5% | 0.59 | 1.07 | 23% | 23% | 76% | 58% | 61% | 0.34 | 1.3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| EMA Golden Cross | 11.6% | 0.61 | 1.16 | 22% | 23% | 70% | 57% | 63% | 0.34 | 0.9 |
| AbsMom | 11.5% | 0.60 | 1.10 | 26% | 30% | 74% | 57% | 63% | 0.33 | 0.9 |
| StormGuard Standard | 11.2% | 0.56 | 0.90 | 24% | 30% | 73% | 59% | 65% | 0.32 | 0.8 |
| 12mMOM | 11.2% | 0.56 | 0.94 | 25% | 30% | 73% | 58% | 65% | 0.31 | 0.7 |
| 10mSMA | 11.3% | 0.59 | 1.10 | 21% | 23% | 69% | 58% | 61% | 0.31 | 1.3 |
| GOOD | 11.2% | 0.55 | 0.90 | 29% | 30% | 73% | 57% | 61% | 0.31 | 0.7 |
| 200dEMA | 11.3% | 0.60 | 1.18 | 21% | 23% | 68% | 57% | 57% | 0.30 | 1.6 |
| SPVOL | 10.2% | 0.45 | 0.50 | 39% | 24% | 69% | 57% | 63% | 0.30 | 3.4 |
| WLIg+ | 11.1% | 0.55 | 1.02 | 28% | 30% | 70% | 56% | 65% | 0.30 | 0.6 |
| Golden Cross | 11.3% | 0.60 | 1.07 | 28% | 30% | 66% | 57% | 61% | 0.29 | 1.0 |
| **LrgCapUS** | 10.0% | 0.41 | 0.41 | 51% | 30% | 64% | | 63% | 0.26 | |
| MiniDipper | 10.9% | 0.56 | 0.91 | 29% | 30% | 63% | 56% | 59% | 0.26 | 1.1 |
| VAA (12-4-2-1) | 10.3% | 0.50 | 0.85 | 19% | 23% | 64% | 58% | 55% | 0.18 | 3.0 |
| **Dec 31, 1967 – Dec 31, 1998** | CAGR | Sharpe | UPI | MaxDD ex 1987 | MaxDD 1987 | WINs | Accuracy, no tolerance | Return ≥ Benchmark | Reliability Index | Switches per year |

**Appendix C. Observations, 1999 – June 2019.** Statistics are determined from the monthly equity curve. Algorithms are ranked by the descending value of the Reliability Index.

Sources: Monthly Allocations Aug 2019.xlsm, workbook Accuracy and SmlOutput08222019.xlsx.

| **Dec. 31, 1998 – Jun 28, 2019** | CAGR | Sharpe | UPI | MaxDD | WINs | Accuracy, no tolerance | Return ≥ Benchmark | Reliability Index | Switches per year |
|---|---|---|---|---|---|---|---|---|---|
| **60:40 Benchmark** | 5.7% | 0.50 | 0.54 | 30% | reference | 60% | reference | reference | Rebalance monthly |
| StormGuard Armor | 13.5% | 1.27 | 5.58 | 8% | 100% | 62% | 100% | 0.85 | 1.4 |
| AbsMom5_1 + DR*PR*VOL + IUC | 10.7% | 0.91 | 2.45 | 12% | 100% | 65% | 80% | 0.77 | 3.5 |
| AbsMom5_1 + DR*VOL + IUC | 10.5% | 0.90 | 2.39 | 12% | 100% | 62% | 80% | 0.74 | 3.5 |
| AbsMom5_1 + DR*VOL | 10.7% | 0.94 | 2.63 | 11% | 100% | 62% | 75% | 0.69 | 2.8 |
| SPVOL + DR*VOL + IUC | 9.5% | 0.79 | 1.43 | 18% | 99% | 63% | 80% | 0.69 | 6.0 |
| SWAG + DR*VOL + IUC | 10.6% | 0.95 | 2.80 | 9% | 100% | 63% | 85% | 0.68 | 3.2 |
| DR*PR*VOL | 11.7% | 1.04 | 3.54 | 10% | 97% | 60% | 80% | 0.67 | 0.9 |
| Modified StormGuard Std + DR*VOL + IUC | 10.2% | 0.90 | 2.30 | 12% | 98% | 65% | 75% | 0.62 | 2.4 |
| 10mSMA + DR*VOL + IUC | 10.1% | 0.90 | 2.57 | 11% | 97% | 63% | 75% | 0.61 | 2.5 |
| AbsMom5_1 | 10.3% | 0.76 | 1.45 | 24% | 98% | 60% | 75% | 0.59 | 2.3 |
| 200dSMA + DR*VOL | 10.9% | 1.00 | 3.30 | 10% | 96% | 60% | 80% | 0.59 | 1.7 |
| DR*VOL | 11.0% | 0.99 | 3.28 | 10% | 95% | 62% | 75% | 0.58 | 0.9 |
| 200dSMA | 10.8% | 0.97 | 3.02 | 10% | 97% | 62% | 85% | 0.56 | 1.0 |
| IUC | 9.9% | 0.72 | 1.33 | 24% | 94% | 60% | 70% | 0.56 | 0.8 |
| SWAG | 10.6% | 0.91 | 2.25 | 13% | 89% | 60% | 80% | 0.56 | 1.9 |
| MiniDipper | 10.1% | 0.90 | 2.01 | 15% | 77% | 61% | 70% | 0.50 | 0.9 |
| AbsMom5 | 9.9% | 0.86 | 2.09 | 14% | 88% | 60% | 70% | 0.47 | 1.9 |
| Golden Cross | 9.7% | 0.83 | 1.98 | 18% | 72% | 61% | 65% | 0.45 | 0.9 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Modified StormGuard Std | 9.5% | 0.79 | 1.43 | 19% | 78% | 61% | 75% | 0.44 | 1.2 |
| GOOD | 9.3% | 0.73 | 1.46 | 16% | 87% | 62% | 65% | 0.43 | 0.6 |
| 200dEMA | 9.6% | 0.84 | 2.01 | 15% | 80% | 59% | 60% | 0.43 | 1.2 |
| WLIg+ | 9.3% | 0.74 | 1.25 | 28% | 83% | 63% | 65% | 0.43 | 0.8 |
| EMA Golden Cross | 9.3% | 0.79 | 1.55 | 15% | 77% | 60% | 70% | 0.42 | 0.7 |
| StormGuard Value Sentiment | 8.9% | 0.70 | 0.81 | 33% | 83% | 55% | 70% | 0.39 | 1.4 |
| 10mSMA | 9.1% | 0.77 | 1.61 | 16% | 79% | 62% | 70% | 0.39 | 1.2 |
| AbsMom | 8.8% | 0.69 | 1.35 | 16% | 80% | 60% | 60% | 0.37 | 0.6 |
| StormGuard Std | 8.7% | 0.67 | 1.09 | 19% | 83% | 60% | 70% | 0.37 | 0.9 |
| AAII (2-1-1-1) | 8.7% | 0.73 | 1.48 | 16% | 80% | 61% | 60% | 0.36 | 1.3 |
| 12mMOM | 8.5% | 0.67 | 1.27 | 16% | 81% | 63% | 65% | 0.35 | 0.7 |
| Nicholas (1-1-1-1) | 8.7% | 0.72 | 1.44 | 16% | 80% | 62% | 60% | 0.35 | 1.1 |
| SPVOL | 7.1% | 0.50 | 0.40 | 39% | 74% | 66% | 60% | 0.34 | 5.2 |
| NHiLo | 8.4% | 0.71 | 0.90 | 29% | 76% | 59% | 65% | 0.30 | 2.7 |
| VAA (12-4-2-1) | 8.1% | 0.66 | 1.04 | 16% | 76% | 64% | 65% | 0.25 | 2.9 |
| StormGuard Market Momentum | 7.8% | 0.65 | 0.90 | 27% | 65% | 63% | 70% | 0.24 | 1.1 |
| **LrgCapUS** | 6.2% | 0.37 | 0.26 | 51% | 60% | 66% | 60% | 0.19 | None |
| MSI Russell 3000 | 4.7% | 0.32 | 0.23 | 51% | 44% | 60% | 50% | (0.09) | 0.7 |
| The following strategies add six bond funds to the allocation options. No timing. | | | | | | | | | |
| FundX Allocation | 7.4% | 0.56 | 1.00 | 22% | 66% | | | 0.16 | |
| DEMA20 Allocation | 6.9% | 0.52 | 0.81 | 19% | 56% | | | 0.12 | |
| Ensemble Allocation | 6.9% | 0.55 | 1.00 | 17% | 62% | | | 0.11 | |
| Dec. 31, 1998 – Jun 28, 2019 | CAGR | Sharpe | UPI | MaxDD | WINs | Accuracy, no tolerance | Return ≥ Benchmark | Reliability Index | Switches per year |

**Appendix D. SIMPLE Strategy, 1999 – June 2019.** The SIMPLE portfolio allocates to the top2 of LrgCapUS, Foreign and REIT, and to IGBOND when the timing algorithm is bearish. The SIMPLE & 6Bonds portfolios allocate to the top2 of LrgCapUS, Foreign, REIT, VFSTX, VWEHX, IGBOND, VFIIX, VUSTX and VWESX. The "Ensemble" algorithm uses the average ranking of the FundX and DEMA20 allocation algorithms.

Statistics are determined from monthly equity curves. Portfolios are ranked by the descending value of the Reliability Index. Prices were updated through August 16, 2019. Source: SmlOutput08222019.xlsx.

| Dec. 31, 1998 – Jun 28, 2019 | Universe | Allocation | CAGR | Sharpe | UPI | MaxDD | WINs | Reliability Index |
|---|---|---|---|---|---|---|---|---|
| **60:40 Benchmark** | **LrgCapUS & IGBOND** | **Fixed** | **5.7%** | **0.50** | **0.54** | **30%** | **reference** | **reference** |
| StormGuard Armor | SIMPLE | Ensemble | 16.0% | 1.45 | 6.73 | 9% | 100% | 1.00 |
| AbsMom5_1+DR*PR*VOL+IUC | SIMPLE | Ensemble | 13.4% | 1.13 | 2.93 | 14% | 100% | 0.92 |
| AbsMom5_1+DR*VOL+IUC | SIMPLE | Ensemble | 13.2% | 1.12 | 2.87 | 14% | 100% | 0.89 |
| SWAG+DR*VOL+IUC | SIMPLE | Ensemble | 13.1% | 1.15 | 3.55 | 12% | 100% | 0.83 |
| SPVOL | SIMPLE | Ensemble | 12.7% | 0.88 | 1.74 | 21% | 100% | 0.82 |
| AbsMom5_1 | SIMPLE | Ensemble | 13.2% | 0.97 | 1.82 | 31% | 100% | 0.80 |
| DR*PR*VOL | SIMPLE | Ensemble | 13.8% | 1.20 | 4.05 | 9% | 99% | 0.79 |
| IUC | SIMPLE | Ensemble | 12.8% | 0.95 | 2.09 | 18% | 100% | 0.78 |
| 200dSMA+DR*VOL | SIMPLE | Ensemble | 13.2% | 1.17 | 4.01 | 9% | 99% | 0.74 |
| 200dSMA | SIMPLE | Ensemble | 13.3% | 1.17 | 3.89 | 9% | 98% | 0.74 |
| SWAG | SIMPLE | Ensemble | 13.0% | 1.10 | 3.04 | 14% | 96% | 0.73 |
| DR*VOL | SIMPLE | Ensemble | 13.1% | 1.15 | 3.82 | 9% | 99% | 0.72 |
| WLIg+ | SIMPLE | Ensemble | 12.3% | 1.01 | 2.23 | 17% | 83% | 0.67 |
| NHiLo | SIMPLE | Ensemble | 12.4% | 1.11 | 3.78 | 9% | 89% | 0.66 |
| StormGuard Standard | SIMPLE | Ensemble | 12.0% | 0.94 | 1.67 | 24% | 93% | 0.65 |
| 5AbsMom | SIMPLE | Ensemble | 12.2% | 1.04 | 2.54 | 14% | 97% | 0.64 |
| StormGuard Modified | SIMPLE | Ensemble | 12.0% | 0.98 | 1.70 | 24% | 95% | 0.63 |
| 200EMA | SIMPLE | Ensemble | 12.1% | 1.04 | 2.73 | 13% | 90% | 0.63 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| GOOD | SIMPLE | Ensemble | 11.6% | 0.93 | 1.87 | 17% | 84% | 0.62 |
| VAA | SIMPLE | Ensemble | 11.9% | 0.97 | 2.33 | 13% | 83% | 0.62 |
| 10mSMA | SIMPLE | Ensemble | 11.8% | 1.00 | 2.37 | 13% | 88% | 0.61 |
| Golden Cross | SIMPLE | Ensemble | 11.8% | 0.99 | 2.64 | 12% | 92% | 0.61 |
| MiniDipper | SIMPLE | Ensemble | 11.8% | 0.99 | 2.64 | 12% | 92% | 0.61 |
| Nicholas | SIMPLE | Ensemble | 11.5% | 0.97 | 2.39 | 13% | 86% | 0.58 |
| EMA Cross | SIMPLE | Ensemble | 11.4% | 0.96 | 1.96 | 16% | 91% | 0.57 |
| 12mMOM | SIMPLE | Ensemble | 11.1% | 0.88 | 1.86 | 17% | 91% | 0.57 |
| AbsMom | SIMPLE | Ensemble | 10.9% | 0.86 | 1.81 | 17% | 91% | 0.54 |
| The following strategies add six bond funds to the allocation options. No timing. | | | | | | | | |
| No Timer | SIMPLE & 6Bonds | FundX | 11.3% | 0.94 | 6.73 | 17% | 78% | 0.53 |
| No Timer | SIMPLE & 6Bonds | DEMA20 | 10.3% | 0.77 | 2.93 | 26% | 92% | 0.45 |
| **No Timer** | **SIMPLE** | **Ensemble** | **9.3%** | **0.54** | **2.87** | **62%** | **82%** | **0.45** |
| No Timer | SIMPLE & 6Bonds | Ensemble | 10.0% | 0.85 | 3.55 | 14% | 88% | 0.40 |
| Dec. 31, 1998 – Jun 28, 2019 | Universe | Allocation | CAGR | Sharpe | UPI | MaxDD | WINs | Reliability Index |

**Appendix E. 27 Fidelity Select Funds, 1999 – June 2019.** Allocation is to the top3 of the funds shown in Appendix G, and to IGBOND when the timing algorithm is bearish. The 27Funds & 6Bonds portfolios allocate to the top3 of the 27 Fidelity funds plus VFSTX, VWEHX, IGBOND, VFIIX, VUSTX and VWESX, without timing. The "Ensemble" algorithm Is the average of the rankings of the FundX and DEMA20 allocation algorithms.

Statistics are determined from monthly equity curves. Portfolios are listed in the descending value of the Reliability Index. Prices were updated through August 16, 2019. Source: SmlOutput08232019.xlsx.

| Dec. 31, 1998 – Jun 28, 2019 | Universe | Allocation | CAGR | Sharpe | UPI | MaxDD | WINs | Reliability Index |
|---|---|---|---|---|---|---|---|---|
| **60:40 Benchmark** | **LrgCapUS & IGBOND** | **Fixed** | **5.7%** | **0.50** | **0.54** | **30%** | **reference** | **reference** |
| StormGuard Armor | 27Funds | Ensemble | 19.9% | 1.08 | 4.16 | 23% | 100% | 0.85 |
| SWAG | 27Funds | Ensemble | 19.0% | 1.02 | 3.61 | 18% | 98% | 0.80 |
| AbsMom5_1+DR*PR*VOL+IUC | 27Funds | Ensemble | 18.1% | 0.95 | 3.16 | 22% | 100% | 0.79 |
| SWAG+DR*VOL+IUC | 27Funds | Ensemble | 18.1% | 0.97 | 3.50 | 21% | 100% | 0.78 |
| AbsMom5_1+DR*VOL+IUC | 27Funds | Ensemble | 17.9% | 0.94 | 3.09 | 22% | 100% | 0.78 |
| AbsMom5_1 | 27Funds | Ensemble | 18.3% | 0.91 | 2.53 | 20% | 100% | 0.76 |
| IUC | 27Funds | Ensemble | 17.9% | 0.87 | 2.63 | 23% | 100% | 0.74 |
| DR*PR*VOL | 27Funds | Ensemble | 17.5% | 0.94 | 3.17 | 23% | 100% | 0.72 |
| 200dSMA | 27Funds | Ensemble | 17.4% | 0.94 | 3.05 | 23% | 100% | 0.71 |
| VAA | 27Funds | Ensemble | 15.7% | 0.92 | 2.58 | 16% | 88% | 0.71 |
| SG Mod | 27Funds | Ensemble | 17.3% | 0.90 | 2.38 | 23% | 97% | 0.70 |
| 200dSMA+DR*VOL | 27Funds | Ensemble | 17.1% | 0.93 | 3.05 | 23% | 100% | 0.70 |
| DR*VOL | 27Funds | Ensemble | 16.8% | 0.90 | 2.86 | 23% | 100% | 0.68 |
| NHiLo | 27Funds | Ensemble | 16.2% | 0.92 | 3.08 | 17% | 100% | 0.67 |
| SG Std | 27Funds | Ensemble | 16.3% | 0.84 | 2.09 | 23% | 93% | 0.66 |
| WLIg+ | 27Funds | Ensemble | 15.9% | 0.87 | 2.25 | 23% | 87% | 0.66 |
| GOOD | 27Funds | Ensemble | 16.0% | 0.83 | 2.04 | 23% | 95% | 0.65 |
| Golden Cross | 27Funds | Ensemble | 16.0% | 0.85 | 2.32 | 23% | 95% | 0.64 |

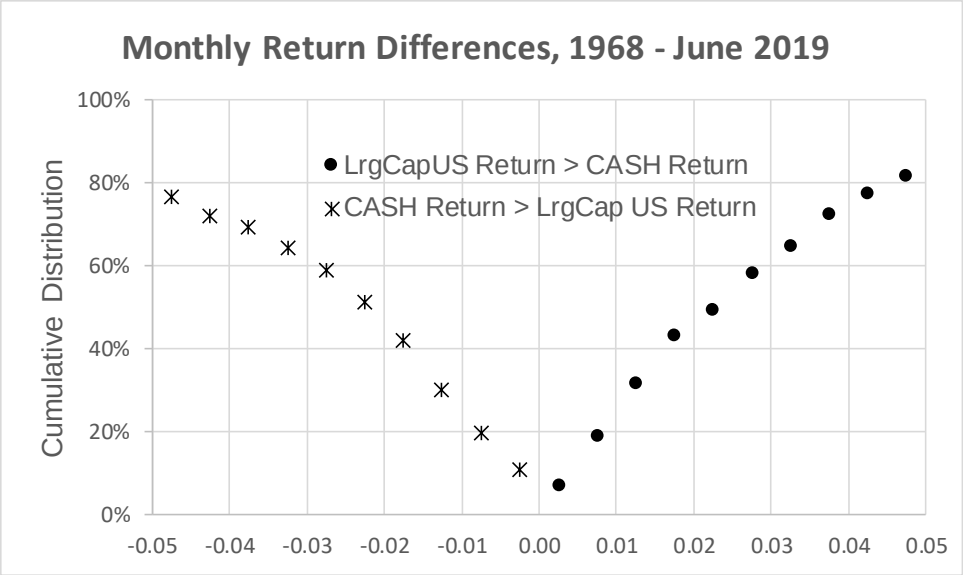
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MiniDipper | 27Funds | Ensemble | 16.0% | 0.85 | 2.32 | 23% | 95% | 0.64 |
| SPVOL | 27Funds | Ensemble | 15.8% | 0.75 | 1.65 | 24% | 99% | 0.63 |
| Nicholas | 27Funds | Ensemble | 15.7% | 0.84 | 2.32 | 23% | 87% | 0.62 |
| 10mSMA | 27Funds | Ensemble | 15.7% | 0.83 | 2.25 | 23% | 88% | 0.62 |
| 200EMA | 27Funds | Ensemble | 15.4% | 0.83 | 2.36 | 23% | 90% | 0.61 |
| 5AbsMom | 27Funds | Ensemble | 15.1% | 0.83 | 2.00 | 21% | 99% | 0.60 |
| 12mMOM | 27Funds | Ensemble | 15.1% | 0.79 | 1.82 | 23% | 92% | 0.60 |
| EMA Cross | 27Funds | Ensemble | 15.2% | 0.81 | 1.83 | 23% | 91% | 0.60 |
| AbsMom | 27Funds | Ensemble | 14.8% | 0.78 | 1.78 | 23% | 92% | 0.58 |
| No Timer | 27Funds & 6Bonds | DEMA20 | 14.9% | 0.72 | 1.27 | 37% | 86% | 0.58 |
| No Timer | 27Funds & 6Bonds | Ensemble | 14.8% | 0.73 | 1.47 | 26% | 97% | 0.57 |
| No Timer | 27Funds | Ensemble | 14.0% | 0.65 | 0.97 | 53% | 86% | 0.55 |
| No Timer | 27Funds & 6Bonds | FundX | 12.2% | 0.60 | 0.63 | 39% | 85% | 0.43 |
| Dec. 31, 1998 – Jun 28, 2019 | Universe | Allocation | CAGR | Sharpe | UPI | MaxDD | WINs | Reliability Index |

# Appendix F. Accuracy and Capture Ratios

## Effect of Tolerances on Accuracy

"Accuracy" as defined here does not distinguish large from small errors. Tolerances were introduced to focus on the larger errors.

The distribution of the differences in the monthly returns of large cap US stocks and of CASH are shown in the following chart. The return difference is less than about -0.01 in twenty percent of the months in which the CASH return exceeds the return of large cap US stocks. It so happens that the return difference is more than about +0.01 in twenty percent of the months in which the return of large cap US stocks exceeds that of CASH. (The distributions are not symmetrical since there are 346 months when the large cap US stock return exceeds that of CASH but only 263 months in which the CASH return exceeds the return of large cap US stocks.)



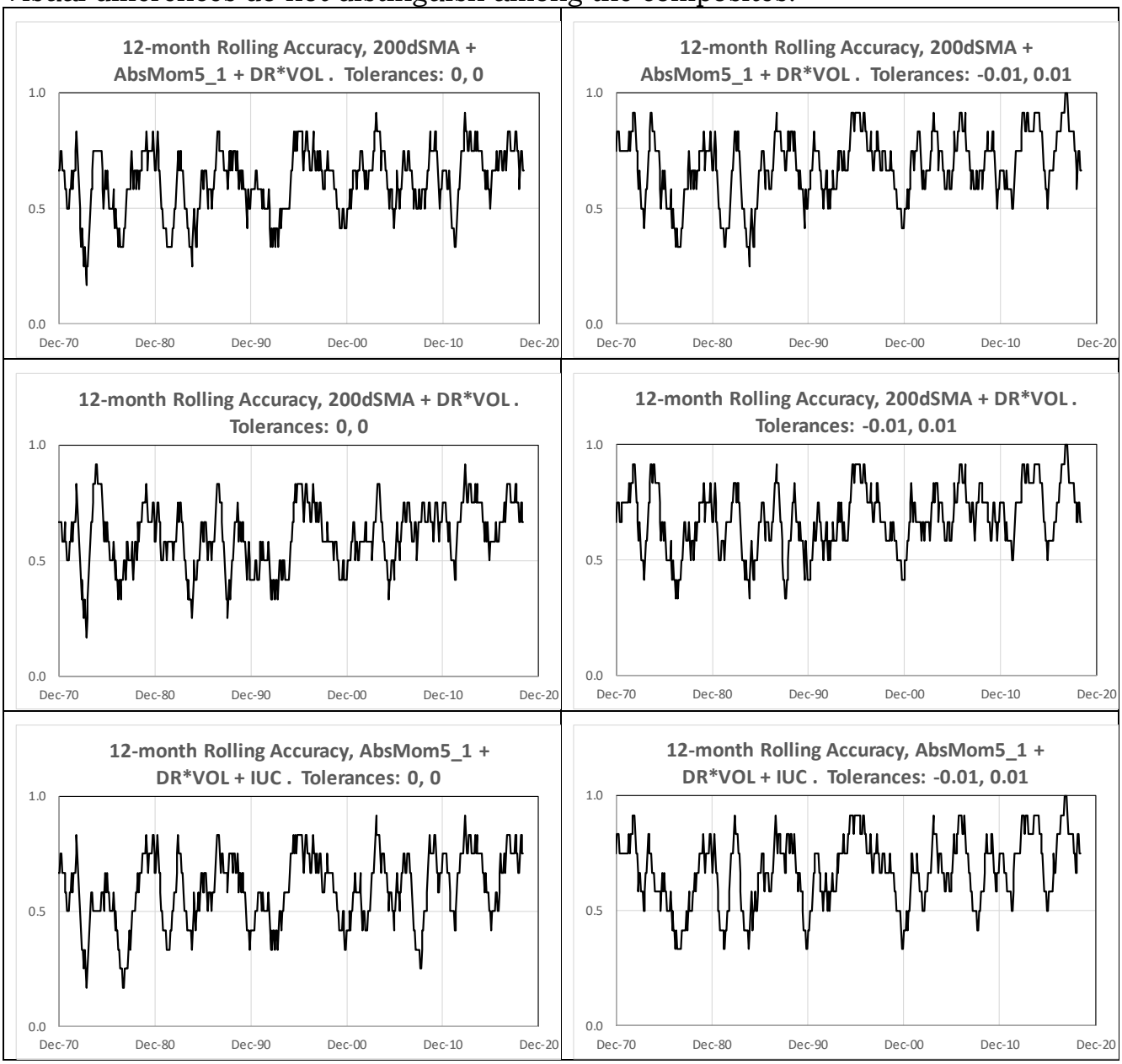

Source: Monthly Allocations July 2019 rev2.xlsm

This chart suggests tolerances of ±0.01. That is, an algorithm is "accurate" when it recommends some allocation to large cap US stocks if the return of large cap US stocks over the following month, minus the CASH return, is greater than or equal to minus 0.01. The algorithm is also accurate when the algorithm recommends CASH if the return of large cap US stocks over the following month, minus the CASH return, is equal to less than 0.01.

As shown in the following table, tolerances do not allow the Accuracy metric to distinguish among the composites.

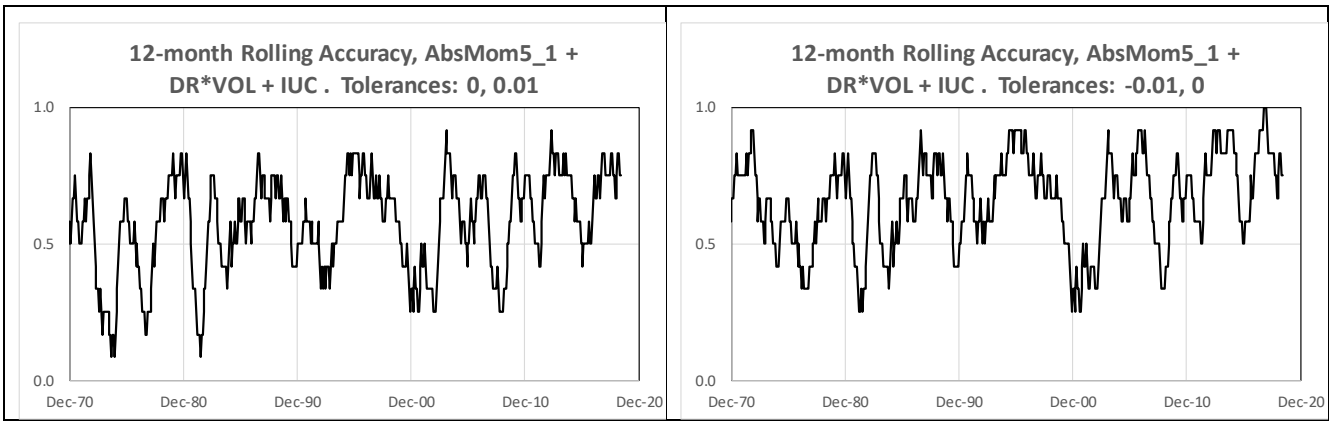
| 1968 – June 2019 | UPI | Average Accuracy | Accuracy, ±0.01 tolerances | Return ≥ Benchmark |
|---|---|---|---|---|
| AbsMom5_1 + DR*VOL + IUC | 1.32 | 60% | 67% | 75% |
| 200dSMA + DR*VOL | 1.45 | 60% | 67% | 63% |
| 200dSMA + AbsMom5_1 + DR*VOL | 1.51 | 61% | 68% | 61% |

Accuracy over rolling 12-month intervals is illustrated in the following charts. Visual differences do not distinguish among the composites.




Source: Monthly Allocations July 2019 rev2.xlsm

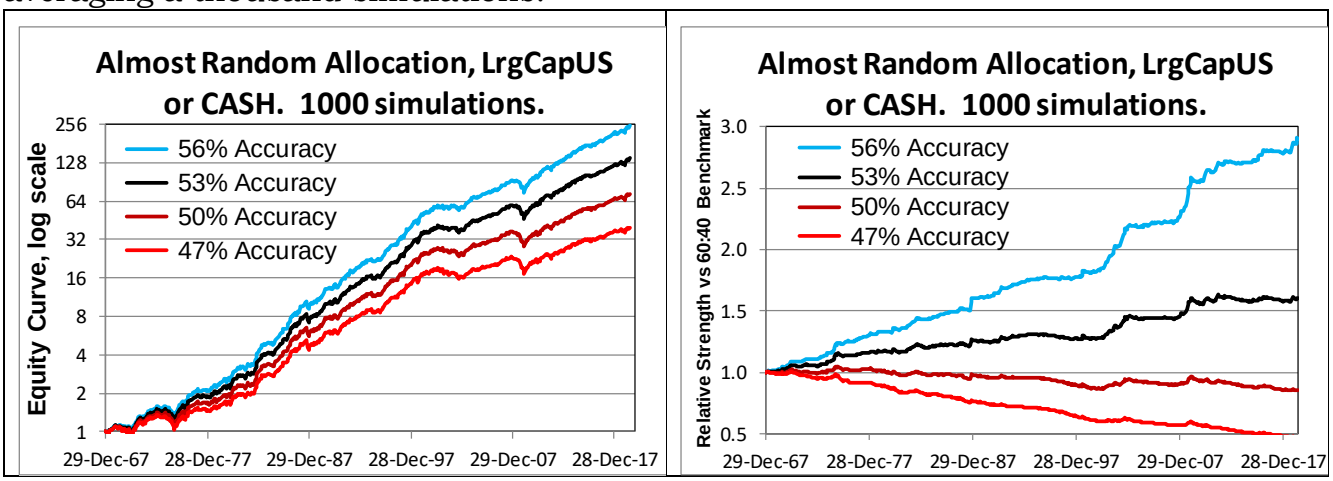
The difficulties that the algorithms experienced in the in the late 1970s and in the 1985-1995 interval appear to be associated with the CASH allocation because a 0.01 tolerance for large cap US stocks has only a limited effect on the rolling accuracy while a minus 0.01 tolerance for CASH has a similar effect to loosening the tolerances for both CASH and large cap US stocks.




## Simulations

Simulated returns are impressive even if an algorithm is only slightly more accurate than random in allocating between large cap US stocks and CASH[11].

The next set of charts were simulated assuming random allocation or "almost random" allocation, random plus a known bias, between large cap US stocks and CASH[12]. The considerable variation between simulations was smoothed by averaging a thousand simulations.




Source: Simulation of Timer Accuracy.xlsb

Statistics are in the following table. The annualized return for a simulation with 50% accuracy is about the same as the historical return of the 60:40 benchmark while the annualized return for a simulation with 58% accuracy is about the same as the historical returns of the composite timers.

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[11] David Zimmermann, "Simulating backtests of stock returns using Monte-Carlo and snowfall in parallel," September 23, 2015. Available at datashenanigan.wordpress.com/2015/09/23/simulating-backtests-of-stock-returns-using-monte-carlo-and-snowfall-in-parallel/. Thanks to John Nicholas for identifying this article and to Jean-Marc Patenaude for technical assistance.

[12] A random number between zero and one is generated each month. Accuracy, the frequency with which a simulation chooses the correct allocation, equals (1+N)/2 where N is a parameter. If the value of the random number is less than (1+N)/2, the return over the following month equals the higher of the return of large cap US stocks or the return of CASH. If the value of the random number is between (1+N)/2 and 1, the return over the following month equals the lower of the return of large cap US stocks or the return of CASH. If N is negative, the relationships are reversed.

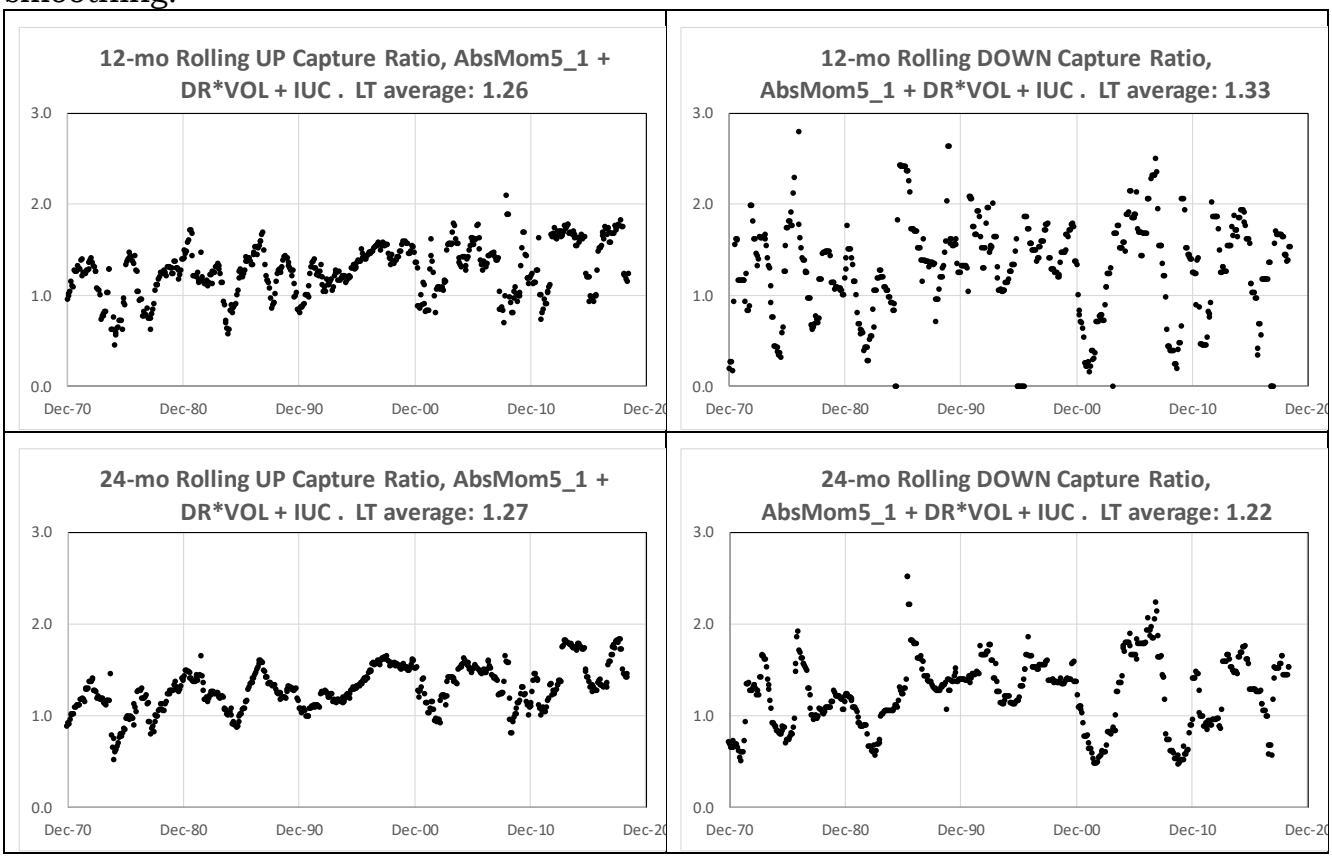
| 1968 - June 2019 | CAGR | Sharpe | UPI | MaxDD ex 1987 |
|---|---|---|---|---|
| 47% Accuracy | 7.4% | 0.35 | 0.45 | 26% |
| 50% Accuracy | 8.7% | 0.50 | 0.76 | 25% |
| 60:40 Benchmark | 9.0% | 0.48 | 0.62 | 30% |
| 53% Accuracy | 10.0% | 0.65 | 1.20 | 22% |
| 56% Accuracy | 11.3% | 0.79 | 1.77 | 20% |
| 58% Accuracy | 12.2% | 0.90 | 2.26 | 18% |
| AbsMom5_1 + DR*VOL + IUC Composite Timing | 12.3% | 0.67 | 1.11 | 24% |

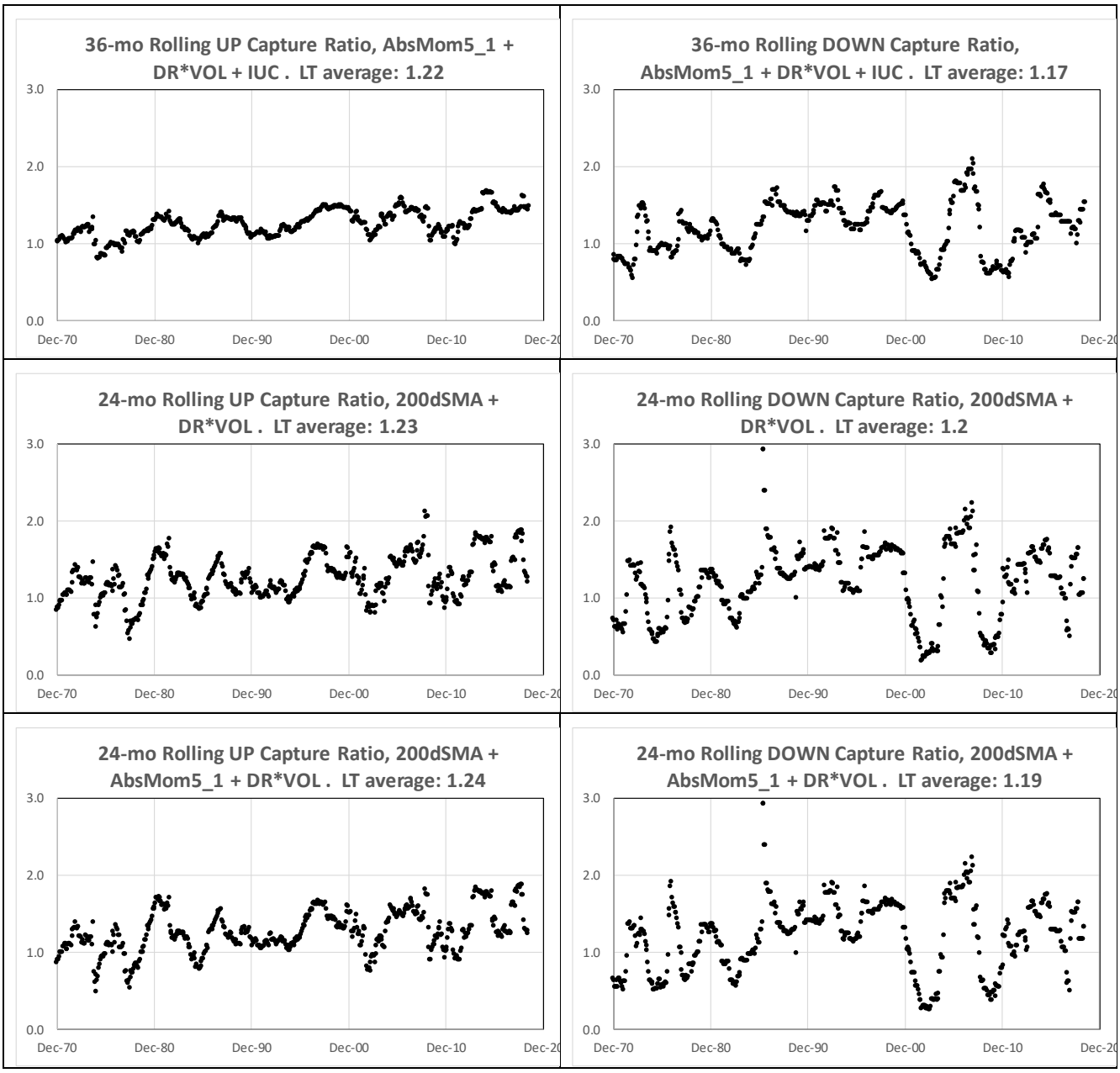
Source: Simulation of Timer Accuracy.xlsb

**Capture Ratios**

The UP-Capture Ratio is the annualized return of the strategy, counting only the months in which the backtested return is positive, divided by the annualized return of the positive months of the benchmark. The DOWN Capture Ratio is the annualized return of the strategy, counting only the months in which the backtested return is negative, divided by the annualized return of the negative months of the benchmark. The months in which the returns of the strategy are positive, or negative, need not be coincident with the like-signed returns of the benchmark.

The charts of UP/DOWN Capture Ratios benefit from at least 24-months of smoothing.






Source: Monthly Allocations July 2019 rev2.xlsm

Both the UP and DOWN Capture ratios generally exceed one. The explanation may be that the timed portfolio is more volatile than the benchmark.

It is not clear that capture ratios provide evidence about reliability.

## Appendix G. Fixed Income Options

**VFSTX**. 2.5-year duration (July 2019). High- and medium-quality, investment-grade corporate bonds, pooled consumer loans, and U.S. government bonds. Inception: October 1982.

VFISX. 2.3 year duration (July 2019). US Treasury securities. Inception: October 1991.

**VWEHX**. 3.2 year duration (July 2019). Medium and lower quality corporate bonds Inception: December 1978.

VFITX. 5.3 year duration (July 2019). US Treasury securities. Inception: October 1991.

**IGBOND**. Intermediate government bonds; extension of SBBI data. Daily data from

**VFIIX**. 4.5 year duration (July 2019). Government-backed GNMA securities. Inception: June 1980.

**VUSTX**. 17.3 year duration (July 2019). US Treasury securities. Inception: May 1986.

**VWESX**. 13.8 year duration (July 2019). Investment-grade corporate bonds. Inception: July 1973.

TLT. 18.1 year duration (July 2019). US Treasury securities. Inception: July 2002.

## Appendix H. Fidelity Select Funds.

A search of Fidelity.com for "select funds" identified 41 funds. Eliminating the six funds without history from before 6/1990 leaves the 35 funds shown below.

Two funds (FSCGX and FSPFX) have been discontinued, two funds (FSHOX and FSLEX) invest in multiple sectors and two funds have data from only 1990. Eliminating these six funds and the money market fund reduces the number of funds to 28. I subsequently eliminated the precious metals fund (FSAGX) for the subjective reason of high volatility.

This leaves the twenty-seven funds shown in the right-hand column.

| Ticker | S&P 500 Category | Name and History | 27 Funds |
|---|---|---|---|
| FBIOX | Healthcare, 99% | Select Biotechnology | FBIOX |
| FBMPX | Discretionary, 98% | Select Multimedia | FBMPX |
| FDCPX | Technology, 99% | Select Computers | FDCPX |
| FDFAX | Staples, 97% | Select Consumer Staples | FDFAX |
| FDLSX | Discretionary, 98% | Select Leisure | FDLSX |
| FIDSX | Financials plus 5% IT | Select Financial Services | FIDSX |
| FRESX | Real Estate | Real Estate | FRESX |
| FSAGX | Precious Metals | Select Gold, Stocks and Bullion | |
| FSAIX | Industrial, 93% | Select Air Transportation | FSAIX |
| FSAVX | Discretionary, 98% | Select Automotive | FSAVX |
| FSCGX | **Discontinued January 2018** | Select Industrial Equipment | |
| FSCHX | Materials, 97% | Select Chemicals | FSCHX |
| FSCPX | **Insufficient history (6/1990)** | Select Consumer Discretionary | |
| FSCSX | Technology plus 3% Discretionary | Select Software & Computer | FSCSX |
| FSDAX | Industrial plus 2% Materials | Select Defense & Aerospace | FSDAX |
| FSDCX | **Insufficient history (6/1990)** | Select Communication Equip. | |
| FSDPX | Materials plus 2% Energy | Select Materials | FSDPX |
| FSELX | Technology, 95% | Select Electronics | FSELX |
| FSENX | Energy, 96% | Select Energy | FSENX |
| FSESX | Energy, 99% | Select Energy Services | FSESX |
| FSHCX | Healthcare, 95% | Select Medical Delivery | FSHCX |
| FSHOX | **Multisector**: 50% Discretionary, 24% Industrial, 18% Financial, 7% Materials | Select Construction & Housing | |
| FSLBX | Financial, 97% | Select Brokerage & Invest Mgmt | FSLBX |
| FSLEX | **Multisector**: 61% Industrials, 18% Materials, 19% other sectors | Select Environment & Alternate Energy, 6/1989 | |
| FSLXX | **Ultra-Short Bonds** | Select Money Market | |

| | | | |
|---|---|---|---|
| FSPCX | Financial, 97% | Select Insurance | FSPCX |
| FSPFX | **Discontinued 2009** | Select Paper & Forest | |
| FSPHX | Healthcare, 96% | Select Health Care | FSPHX |
| FSPTX | Technology plus 5% Discretionary | Select Technology | FSPTX |
| FSRBX | Financial plus 2% Technology | Select Banking | FSRBX |
| FSRFX | Industrial plus 2% Energy & Financial | Select Transportation | FSRFX |
| FSRPX | Discretionary plus 4% Staples & Technology | Select Retailing | FSRPX |
| FSTCX | Technology plus 9% Financial | Select Telecommunications | FSTCX |
| FSUTX | Utilities plus 19% Energy | Select Utilities | FSUTX |
| FSVLX | Financial plus 19% Technology | Select Consumer Finance | FSVLX |