Predictive Equity Analytics: Portfolio Crisis Proofing and Superior Returns

Abstract

Investor's returns are enhanced by predictive equity analytics ability to avoid drawdowns and capture gains in bull or bear markets. Predictive equity analytics enables optimal stock selection, timing and bid price with accuracy and reliability. Portfolio value behavior over time is positive and generally a non-decreasing step function. Next trade day predictive equity filtering significantly reduces left tail risk enabling positive returns with high probability. Hedging (crisis proofing) of equity portfolios is a natural artifact of predictive equity analytics with no additional cost and no additional financial instruments required. Portfolios are dynamically constructed using dynamic diversification with higher Sharpe ratios and maximal investment efficiency. Predictive equity analytics enables mean-variance return dominance.

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Introduction

Big data and machine learning applied to stock price analysis is a topic of vigorous current research. Researchers strive to discover data sets with predictive power in-sample as well as out of sample based on a sufficiently strong correlation over time. Poor model performance of in sample versus out of sample is commonly reported after much time, effort and computing cost. To date, little attention has been given to the effect of noise contained in stock price series observations themselves as well as to noise contained within explanatory "big data sets." Mathematically, the correlation function is sensitive to a single large outlier or subset of "small" outliers. In this paper we focus on the effect of noise within stock price series observations and defer noise contained in big data sets for future analysis. We show that it is possible to differentiate with sufficient clarity between inherent process variance and noise.

Detection of signals from noisy observations is a common problem found in communication transmission lines, satellite tracking and radar applications to name a few examples. We study stock (equity) price series to determine whether the observed price data elements contain a signal and noise or merely noise. Investigative steps include: 1) if signal and noise then subsequent filtering step is applied to recover the signal, 2) if noise, sample until sufficient signal detected.

Our stock price direction signal problem is similar In nature to a radar problem where a signal is sent and (if reflected) then the received data are checked to determine whether the data contain a reflected signal and noise or only noise. As an example, storm intensity tracking using radar which has strong down fall areas (red/yellow) and lighter down fall areas (dark green / green) which are dynamically changing with time. The features of interest are transition boundaries between heavy and light rain (signal detection of mixture of distributions with noise) as well as small patches of heavy rain (outlier effects – strong signal, low noise, narrow localized occurrence.)

Current market offerings of passive or active investment strategies fall short of meeting investors goals. Passive investment strategies seek to mimic an index. Passive investment strategies are incapable of mitigating or eliminating drawdown risk. Active management investment seeks to outperform benchmarks and should mitigate drawdown risk but has proved susceptible to drawdown risk and even performed worse than passive strategies albeit at higher cost.

Until now investors had two choices: a) increase allocations to debt instruments, accept lower return with lower risk or b) increase allocation to equities and attempt to capture higher return accompanied by higher drawdown risk. Either way some flavor of "buy and hold" and hope for the best is all that could be offered.

Investors want to achieve high return with limited drawdown risk in the most efficient way with respect to time and return maximization. Once investors accumulated portfolio value has grown, they naturally want drawdown protection through some type of hedging or portfolio insurance. In this paper we will we show that predictive equity analytics is the

solution to the stock price direction signal problem and also a natural hedging strategy without additional cost or need for additional instruments.

Given the current and future low interest rate environments, how can Investors achieve their return objectives without exposing themselves to substantial drawdown risk?

In this paper we propose a new solution, predictive equity analytics, that is able to avoid drawdowns and capture gains (long run and short run) thus satisfying investors desire to achieve high returns with limited drawdown risk. The basic idea is simple and immensely powerful. If an investor had equity price direction prediction capability that was sufficiently reliable, how would s/he invest? [1]

> Answer: purchase stocks predicted to increase, sell stocks predicted to decrease if owned and short stocks predicted to decrease if not owned. Diversification would be re-defined as "dynamic diversification" weighting allocations to the set of stocks expected to increase in price. Up-front costs of implementing pre-defined portfolios to capture gains and diversify risk are re-scoped to only those stock expected to increase in price with full investment or partial investment and the remainder in a side interest bearing account.

> Veracity of predictive capability accuracy can be measured in three ways: 1) back testing over some historical period, 2) going forward from series of next trade day predictive analysis reports and 3) overview of underlying financial, economic, behavioral and statistical theory.

Predictive equity capability implies that left-tail return distribution risk has been eliminated, censored in some way or significantly reduced. All investors desire high returns with little to no drawdown risk so the concept of investor risk preference to differentiate risky portfolio preference is a third order consideration.

The first success of predictive equity analytics was the successful construction of upper and lower bounding stochastic trend series that precluded uniform bounding of daily trend (too wide is not useful, nor is too tight) by design. The bounding series is sufficient for drawdown risk warning purposes but not for gain capture.

The key break-through was generation of signals {1,2,3} from which predictive rule set patterns could accurately and reliably be learned and observed. More importantly the predictive rule set is based on solid economic, financial and human behavioral underpinnings with affirmative causality. As an example:
> Using Apple's predictive rule set, 2018 Fall and 2020 spring drawdowns are predicted and avoided. 2018 Fall downturn was avoided on Oct. 4, 2018 and 2020 Spring downturn was avoided on Feb. 6, 2020. Signal 3 strength of 0.6 or greater is

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[1] Hollywood movie themes include prediction in the form of a prop or person: "crystal ball", "Aladdin's lamp," "the oracle," "savant," "time machine" and "time traveler."

considered a sufficiently strong signal to warrant examination.[2]

Prediction equity lacks capability to predict IRS 60 holding-day period for favorable capital gains treatment. Tax optimization is a lower order concern.[3] We would argue that where favorable IRS tax treatment can be achieved along with equity prediction, the investor should do so as opportunities present themselves.

Predictive equity analytics is applied to U.S. equities. International predictive equity analytics entails additional risks: a) currency risk, b) sovereign yield curve risk and may or may not add to returns already enabled by predictive equity analytics using U.S. equities.

We do not explore predictive equity analytics for options, forwards, futures or derivatives at this time.

Our presentation starts with active equity management performance measurement culminating in the fundamental law of active management. The underlying security model behavior is viewed not as a single model but as a filtering that creates two models: positive trend model and negative trend model. There are 22 total fields carried for each equity with 13 fields of value-added information from predictive equity modeling application. Predictive rule sets are derived from series signals {1,2,3}. Application of the predictive rule sets each trade day results in a color encoded heat map. Purchasing of equities color encoded to increase in price and sell those expected to drawdown creates dynamically diversified portfolios with minimal risk. We use the heat maps for DJIA and SP500 for years 2020 and 2019 to create dynamic portfolios and compare to YTD index return. We show that through left tail filtering, dynamic portfolios are positive valued generally non-decreasing step functions over time. Predictive equity analytics significantly outperforms indexes in bear markets and in the long run outperforms indexes in bull markets as shown in appendix. Predictive equity analytics diagnostics are provided in appendix.

Active equity management using predictive equity analytics
The optimal risky portfolio is a combination of two component portfolios:
(1) an active portfolio, denoted by A, comprised of analyzed securities (this is
the active portfolio because it derives from a combination of equity prediction analytics and security analysis), and (2) the market index portfolio denoted by M. The optimal risky portfolio differs from standard "smart beta portfolios" in that predictive signals are generated each trade day without using a market portfolio basis.

Superior performance arises from active investment decisions which differentiate the portfolio from a "passive" benchmark. These decisions include:
- Market timing: altering market risk exposure through time to make advantage of market fluctuations.
- Sector weighting: weighting towards (or away from) company attributes, such as size, leverage, book/price, and yield, and towards (or away from) industries.

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[2] See Exhibit 2 on page 10.
[3] See IRS Publication 550: Investment Income and Expenses.(https://www.irs.gov/pub/irs-pdf/p550.pdf)

- Security selection: making informed bets based on information idiosyncratic to individual securities.

Successful active management consists of efficient investment based on superior predictive information. It has two key elements: creating superior predictive "alpha signal" information, and efficiently trading based on that information.

Adding active predictive equity to the information ratio (*IR*) is the key to high, stable returns

Maximization of the information ratio can only be achieved by incorporating equity predictive analytics as a technology and as a fund manager investment style. The goals of equity predictive analytics are:

1. avoid drawdowns or actively mitigate to furthest extent possible,
2. capture highest short run / long run returns with associated lowest risk,

which is accomplished through active stock selection and timing based on "alpha signal generation/detection" for next trade-day.

The Fundamental Law of Active Management:[4]

Grinbold and Kahn argued that once an investor possessed "superior information," the optimal framework to measure effectiveness focuses on the information ratio (*IR*). "Every investor seeks the strategy or manager with the highest information ratio." Different investors will differ only in how aggressively they implement the strategy.

The information ratio is defined as:

$$IR = IC\sqrt{Breadth(BR))}$$

where:

- BR is the strategy's breadth. Breadth is defined as the number of independent forecasts of excess return made per year.

- IC is the manager's information coefficient. IC measures the correlation of each forecast with the actual return outcomes.

Typically, a manager's IC is low and breadth is high. High turnover is associated with potentially high transaction costs and does not necessarily indicate favorable net investment return.

How do you maximize *IR* and assure favorable net investment return?

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[4] The majority information can be found in [5] Grinbold, Richard and Kahn, Ronald. The question of how to find or generate superior investment information is an open question.

Sector and security analysis are the standard sources for gleaning "superior information," per Grinold and Kahn. Data science as applied to security analysis is a current area of high activity. In this context, superior information means information not already impounded in a stock's closing price and not publicly known. The general availability of data, low cost of cloud computing power and a similarly trained workforce makes finding or manufacturing of superior information difficult, a low yield proposition and finite duration before discovery by others.

Combing sector analysis, security analysis with equity predictive analytics enables significant high-quality superior information generation to maximize next trade-day *IR*.

1. The ability to forecast each stock's expected return different from consensus using equity predictive analytic signals enables stock selection and timing to increase the information coefficient, *IC* while minimizing drawdown risk.

2. The second element leading to a larger information ratio is breadth, the number of times per year that superior information is actively traded on. Equity predictive analytics generates signals for 4,500+ stocks each trade-day prior to market open for "alpha stock detection" which makes for a large breadth.

The value-added (VA) active investment amount, at risk aversion level λ_R , to a fund is measured by:[5]

$$VA[\omega_p] = \omega_p * IR - \lambda_R * \omega_p^2$$

The optimal level of residual risk, ω^*, which maximizes $VA[\omega_P]$ is:

$$\omega^* = \frac{IR}{2\lambda_R}$$

The desired level of residual risk will increase with our opportunities and decrease with our residual risk aversion. Doubling the information ratio will double the optimal risk level. Doubling the risk aversion will halve the optimal risk level.

The relationship between the value added as measured by utility and the manager's opportunity as measured by the information ratio *IR*:

$$VA^* = VA[\omega^*] = \frac{IR^2}{4\lambda_R} = \frac{\omega^* * IR}{2}$$

This says that the ability of the manager to add value increases as the *square* of the information ratio and decreases as the manager becomes more risk averse.

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[5] This material can be found in [5] Grinold, Richard and Kahn, Ronald.

Equity Price Model

For the sake of exposition, assume stock price model for S_t with continuous dividend rate D_t as follows:

$$\frac{dS_t}{S_t} = (\mu_t - D_t)dt + \sigma_t dW_t$$

Stock price time series is assumed to solve the following stochastic differential equation under the risk-neutral , Q measure using risk-free rate r_t:

$$\frac{dS_t^Q}{S_t} = (r_t - D_t)dt + \sigma_t dW_t$$

We break from standard theory at this point and hypothesize that rather than one statistical model, we have two statistical models for S_t behavior. A positive filtering for increasing trend process and a negative filtering for decreasing trend process. Left tail risk is significantly reduced by negative trend filtering model indicator of downward trend in short run or long run.

Model 1 behavior applies positive trend filtering, P that removes the majority of negative returns, retains positive returns and dynamically weights to expected positive return sub-components. This allows for negative returns which occur from time to time but are small in nature and with dynamic diversification minimized. ```

Model 1 - Overall Positive Trend

$\frac{dS_t^P}{S_t} = (\mu_t^P - D_t)dt + \sigma_t^P dW_t^P \geq 0$ almost surely in mean-variance

$for\ any\ combination\ of\ \{(\mu_t^P - D_t), \sigma_t^P dW_t^P\}\ such\ that\ \approx \frac{dS_t^P}{S_t} \geq 0.$

> *where more narrow assumptions are*:
> $\approx -0.01 \leq dW_t^P\ is\ a\ censored\ normal\ random\ variable\ at -0.01,$
> $-\infty < (\mu_t^P - D_t) < \infty,$
> $\sigma_t^P \geq 0,$
> $D_t \geq 0\ is\ continious\ dividend.$

> Indicator positive trend model is commencing or is active: $I_t^P\ with\ probability\ 0 \leq p(I_t^P) \leq 1$

Model 2 behavior applies negative trend filtering, N that removes the majority of positive returns, retains negative returns and dynamically weights to expected negative return sub-components. This allows for positive returns which occur from time to time but are small in nature and with dynamic diversification minimized.

Model 2 - Overall Negative Trend

$$\frac{dS_t^N}{S_t} = (\mu_t^N - D_t)dt + \sigma_t^N \, dW_t^N \leq 0 \text{ almost surely in mean-variance}$$

$$for \; any \; combination \; of \; \{(\mu_t^N - D_t), \sigma_t^N dW_t^N\} \; such \; that \; \approx \frac{dS_t^N}{S_t} \leq 0.$$

> *where more narrow assumptions are*:
> $\approx dW_t^N \leq 0.01 \; is \; a \; censored \; normal \; random \; variable \; at \; 0.01,$
> $-\infty < (\mu_t^N - D_t) < \infty,$
> $\sigma_t^N \geq 0,$
> $D_t \geq 0 \; is \; continious \; dividend,$
>
> Indicator negative trend model is commencing or is active: $I_t^N \; with \; probability \; 0 \leq p(I_t^N) \leq 1$

Given filters $\{P, N\}$, mean-variance dominance of equity returns with positive skewness and excess kurtosis follows by purchasing stocks expected to increase and selling or shorting stocks expected to decrease.

Overall horizontal S_t behavior is the compliment set $\{P, N\}^C$ with probability $1 - p(I_t^P) - p(I_t^N)$. For horizontal behavior, an investor is better off maintaining liquidity by investing in an interest- bearing account or riskless U.S. Treasury instrument and waiting for the next positive return generating opportunity. It is not optimal to be invested in horizontal moving stocks or stocks with return distributions that are mean variance dominated by return distribution of high rated bonds or U.S. Treasury instruments.

The filters, $\{P, N\}$ on $[t, t+1)$ are forward looking and act to identify the subset of stocks expected to increase which are purchased prior to market open and also act to identify the subset of stocks expected to decrease which are sold prior to market open if currently owned.[6] Short selling of stocks expected to decrease is allowed. To maintain a degree of dynamic diversification a minimum of 3 to 5 stocks with expected positive returns is generally recommended. The larger the set of expected positive return stocks available the higher the degree of dynamic diversification albeit with some degree of return opportunity sacrifice.

Existence and sufficiency of $\{P, N\}$

$\{P, N\}$ filter construction is proprietary. $\{P, N\}$ filter theory and framework are rooted in economic, financial, human behavioral foundations. Existence and sufficiency of $\{P, N\}$ is supported by theory as well as by providing historical 500 trade-day TRI-SIGNAL predictive results containing bull and bear markets and measuring predictive accuracy. Alternatively, a forward-looking accuracy verification is also available. It would be "impossible" to accurately

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[6] Immediately breaking news impact news are outside of model scope.

predict the behavior of 4,500+ stock prices for over 500 trade-days without an accurate and reliable modeling framework.

Data:

DJIA and SP500 index data for 2020 and 2019 will be used for analysis. 2019 was a bull market overall while 2020 is considered a bear market due to Cornv-19 pandemic economic effects. The DJIA index will be used for demonstration purposes via 27 stock sub sample for period Jan 2 thru Aug. 10, 2020. Stock data is contained in rows and column data is trade-date.

	Stock_sym	Company,	Sector:	Exchange:	Column_S	Trade_date:	2/19/2020	2/20/2020
530	AAPL	Apple Inc.	Electronic Tec	NASDAQ		current_stock_price:	323.619995	320.299988
531	AAPL	Apple Inc.	Electronic Tec	NASDAQ		next_trade_day_est_high_price:	325.9108744	327.0682853
532	AAPL	Apple Inc.	Electronic Tec	NASDAQ		next_trade_day_est_low_price:	315.1105398	319.0178865
533	AAPL	Apple Inc.	Electronic Tec	NASDAQ		trade_day_est_high_percent_price:	1.021664183	1.010655368
534	AAPL	Apple Inc.	Electronic Tec	NASDAQ		trade_day_est_low_percent_price:	0.987807335	0.985779283
535	AAPL	Apple Inc.	Electronic Tec	NASDAQ		long_run_comment:	Long_run_favorable-upward_trend_with_unstable_volatility	Long_run_significant-strength_upward_trend_with_unstable_volatility
536	AAPL	Apple Inc.	Electronic Tec	NASDAQ		pe_ratio:	25.37	25.11
537	AAPL	Apple Inc.	Electronic Tec	NASDAQ		volume:	23429149	25032451
538	AAPL	Apple Inc.	Electronic Tec	NASDAQ		market_capitalization:	1.41599E+12	1.40147E+12
539	AAPL	Apple Inc.	Electronic Tec	NASDAQ		volatility:	non-stable	non-stable
540	AAPL	Apple Inc.	Electronic Tec	NASDAQ		daily_trend:	1.014482743	0.989741033
541	AAPL	Apple Inc.	Electronic Tec	NASDAQ		exceed_upper_bound:	0	0
542	AAPL	Apple Inc.	Electronic Tec	NASDAQ		exceed_lower_bound:	0	0
543	AAPL	Apple Inc.	Electronic Tec	NASDAQ		stock_direction_signal_1:	0	0
544	AAPL	Apple Inc.	Electronic Tec	NASDAQ		stock_direction_signal_2:	0.8	0.8
545	AAPL	Apple Inc.	Electronic Tec	NASDAQ		stock_direction_signal_3:	0.975	0.95
546	AAPL	Apple Inc.	Electronic Tec	NASDAQ		long_run_optimal_buy_ind:	0	1
547	AAPL	Apple Inc.	Electronic Tec	NASDAQ		trade_day_252_high:	327.85	327.85
548	AAPL	Apple Inc.	Electronic Tec	NASDAQ		trade_day_252_low:	169.49	169.5
549	AAPL	Apple Inc.	Electronic Tec	NASDAQ		date - stockprice - realized daily trend - (std_dev : long_run_trend)	2020-02-19 - $323.62 - 1.01448 - (1.00015 : 0.99818)	2020-02-20 - $320.30 - 0.98974 - (1.00025 : 0.97033)
550	AAPL	Apple Inc.	Electronic Tec	NASDAQ		std_dev_of_proxy_that_tracks_changes_in_true_unobserved_trend_di	1.000150011	1.000250031
551	AAPL	Apple Inc.	Electronic Tec	NASDAQ		mean_of_proxy_that_tracks_changes_in_true_unobserved_trend_distr	0.998180803	0.970326297

Exhibit 1

Exhibit 1 shows the data layout using Apple (AAPL) for illustration purposes. There are 22 data items carried for each stock for moving 121 trade-day history. Firm variables include symbol, corporate/symbol name, exchange, sector, market capitalization, p/e ratio, volume, 252 trade-day high price, 252 trade-day low price, close price (unadjusted) and daily trend.

Contained with the 22 fields there are 13 value-added TRI-SIGNAL predictive fields:
1) next trade day est. high price,
2) next trade day est. low price,
3) next trade day est. high percent price,
4) next trade day est. low percent price,
5) long run comment,
6) volatility stability assessment,
7) stock directions signals {1,2,3},
8) long run optimal buy indicator,
9) date – stock price - realized daily trend - (stddev : long_run_trend),
10) std_dev_of_proxy_tracks_changes_in_true_unobserved_trend_distribution,
11) mean_of_proxy_that_tracks_changes_in_true_unobserved_trend_distribution

Asymmetric estimation of next trade-day trading range price and percentage.

Predictive Signals for {P,N} filters.

Mean-variance analysis

The SP500 data consists of 371 sub sample for 2020 and 471 sub sample for 2019. The same 22 data fields are available for each individual stock.

{P,N} Filters and predictive signals for individual stock

Exhibit 2 illustrates TRI-SIGNAL signals {1,3} for Apple (AAPL) used in predictive buy/sell rule set construction. Signal 2 is not shown due to low reliability. Standard calculus function behavior analysis (min/max), (domain increasing function, domain decreasing function) is performed albeit in statistical sense using signals {1,3}. Signal 1 acts to identify local maxima and minima as well as inflection points analogous to horizontal tangent criteria. Signal 3 acts in function behavior role over a domain e.g. function increasing, function neither increasing nor decreasing or function decreasing. In bull or bear markets (darker red shaded time period), series {1,3} affirmatively predict the starting and ending points of positive trend series and negative trend series with high accuracy and reliability.

Interactive 477 Trade-day TRI-SIGNAL Next Trade-day Stock Direction Predictive Graph: Apple (AAPL)

Explore interactive graph by selecting a stock and then mousing over chart or select signal by clicking on legend label.

Visual Signal Pattern for Next Trade-day Stock Price Direction:**
Signal 1 > = 0.6 is predictive for local peaks and inflection points.
Signal 3 >= 0.97 or tending up indicates increase.
Signal 3 < 0.97 or tending down indicates decrease.
Signal 1 > = 0.6 and (Signal 3 >= 0.97 or Signal_3 trending up from 0.95) is predictive for price increase with accuracy 85%+.
Signal 1 > = 0.6 and (Signal 3 < 0.97 or Signal_3 trending down from 0.97) is predictive for price decrease with accuracy 85%+.

Note: 2020 Spring and 2018 Fall market downturns are highlighted in light red.
** Some stocks require signal 3 threshold adjustment for accuracy 85%+, e.g. Nvidia (NVDA) threshold is 0.95 rather than 0.97.

Stock List: AGILENT TECHNOLOGIES (A)   APPLE (AAPL)   JPMORGAN (JPM)   NVIDIA (NVDA)   UNION PACIFIC RAILROAD (UNP)
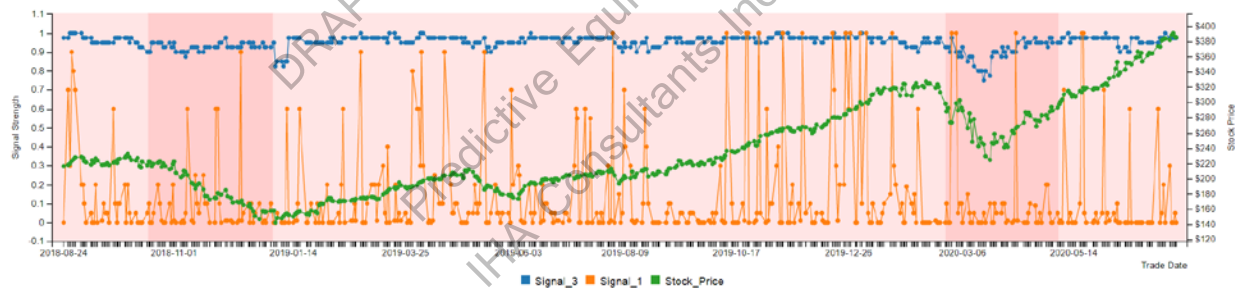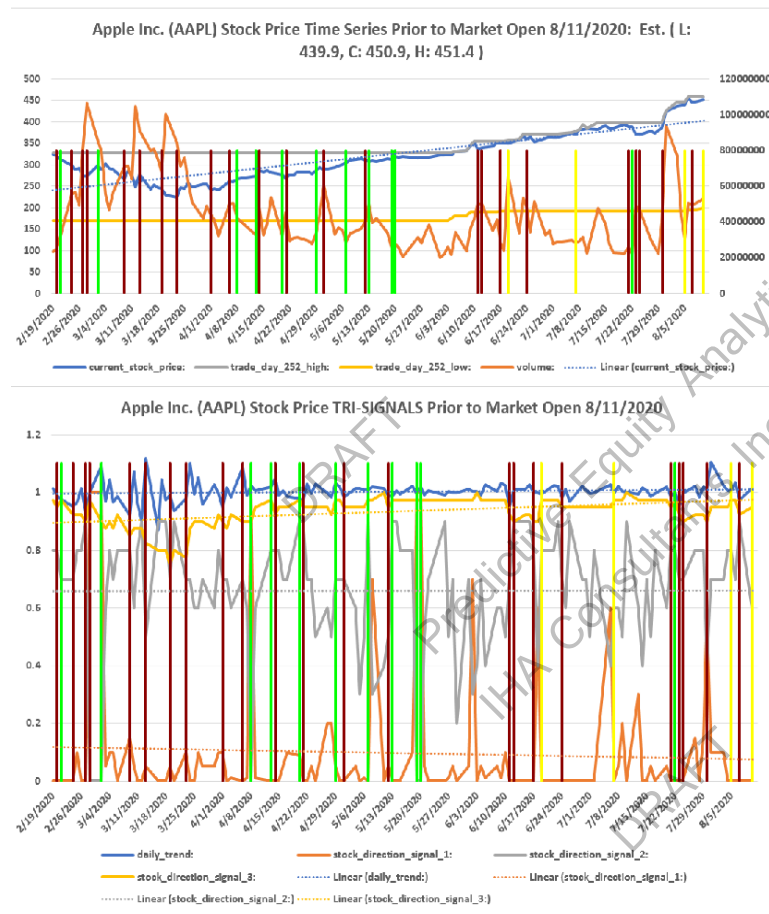
Exhibit 2

Using Apple's predictive rule set, 2018 Fall and 2020 spring drawdowns are predicted and avoided. 2018 Fall downturn was avoided on Oct. 4, 2018 and 2020 Spring downturn was avoided on Feb. 6, 2020. Signal 3 strength of 0.6 or greater is considered a sufficiently strong signal to warrant examination. Series 1 is examined alone or in conjunction with Series 3 to determine next trade-day predicted stock price direction. Series 1 signal of 0.97 or greater or series signal 1 locally increasing indicates expected next trade-day price increase. Series 1 signal of less than 0.97 or series signal 1 locally decreasing indicates expected next trade-day price decrease. See Exhibit 2 for predictive rule details.

In general, the predictive rule set using series signals {1,3} is 85%+ accurate for next trade-day trend prediction. The combined accuracy of signals {1,3} and mean-variance analysis exceeds 90%. Firm specific research can boost reliability to 95% or better.

In any evert, drawdowns are 100% detected within 1 trade-day and confirmed within 2 consecutive trade-days.

Automated graphical predictive signal reports for short run and long run buy and sell are available as shown in Exhibit 3. Current optimal purchase price is deduced from examining short run buy date-price and similarly for long run. Interpretation of Series 1 and Series 3 signal history for reliability is also shown. Firm specific links for news events and general information are available at the bottom. TRI-SIGNAL buy/sell indications occur prior to market open for a given date and precede daily reported trade volumes which are reported at the end each trade-day.

Apple Inc. (AAPL) Stock Price Time Series Prior to Market Open 8/11/2020: Est. (L: 439.9, C: 450.9, H: 451.4)

Apple Inc. (AAPL) Stock Price TRI-SIGNALS Prior to Market Open 8/11/2020

Apple Inc. (AAPL) Stock Price TRI-SIGNALS Prior to Market Open 8/11/2020 (AAPL)				
Date	Date	Close Price	Short-run	Long-run Buy/Sell
8/11/2020	8/11/2020			
8/10/2020	8/10/2020	450.91	No Action	No Action
8/7/2020	8/7/2020	444.45	Sell	
8/5/2020	8/5/2020	440.25	No Action	
7/30/2020	7/30/2020	384.76		Buy
7/24/2020	7/24/2020	370.46	Sell	Buy
7/23/2020	7/23/2020	371.38	Sell	
7/22/2020	7/22/2020	389.09	Buy	
7/21/2020	7/21/2020	388	Sell	
7/7/2020	7/7/2020	372.69	No Action	
6/24/2020	6/24/2020	360.06	Sell	
6/19/2020	6/19/2020	349.72	No Action	
6/17/2020	6/17/2020	351.59	Sell	
6/12/2020	6/12/2020	338.8	Sell	
6/11/2020	6/11/2020	335.9	Sell	
5/20/2020	5/20/2020	319.23	Buy	Buy
5/19/2020	5/19/2020	313.14	Buy	Buy
5/13/2020	5/13/2020	307.65	Buy	
5/12/2020	5/12/2020	311.41	Sell	
5/7/2020	5/7/2020	303.74	Buy	
5/1/2020	5/1/2020	289.07	Sell	
4/29/2020	4/29/2020	287.73	Buy	
4/21/2020	4/21/2020	268.37	Sell	Buy
4/20/2020	4/20/2020	276.93	Buy	Buy
4/14/2020	4/14/2020	287.05	Sell	
4/13/2020	4/13/2020	273.25	Sell	
4/8/2020	4/8/2020	266.07	Buy	Buy
4/6/2020	4/6/2020	262.47	Sell	
4/1/2020	4/1/2020	240.91	Sell	Buy
3/23/2020	3/23/2020	224.37	Sell	Buy
3/19/2020	3/19/2020	244.78	Sell	
3/13/2020	3/13/2020	277.97	Sell	
3/9/2020	3/9/2020	266.17	Sell	Buy
3/2/2020	3/2/2020	298.81	Buy	Buy
2/28/2020	2/28/2020	273.36	Buy	Buy
2/27/2020	2/27/2020	273.52	Sell	
2/24/2020	2/24/2020	298.18	Sell	
2/21/2020	2/21/2020	313.05	Buy	
2/20/2020	2/20/2020	320.3	Sell	Buy

URL Information Links:
https://www.barrons.com/quote/stock/AAPL
https://quotes.wsj.com/AAPL?mod=md_home_hdr_search
https://finance.yahoo.com/quote/AAPL?p-AAPL&.tsrc-fin-srch

Exhibit 3

Mean-variance analysis tracking discussed next is used as an additional independent confirming test to predictive rule set. [7]

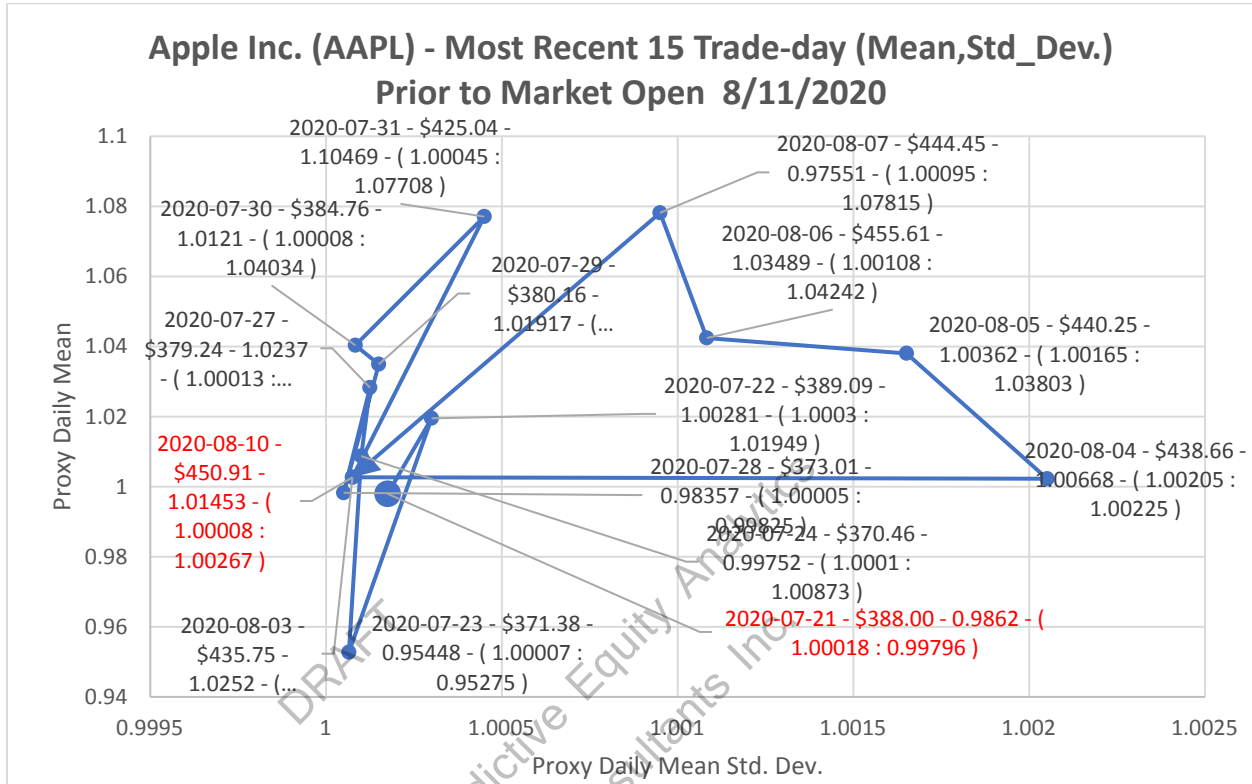**Mean-variance Performance Analysis and Tracking**

Exhibit 4

The purpose of tracking mean-variance performance over time is to compare the realized daily trend as generated from the forecast long run trend proxy distribution (mean, variance). From regression analysis, time series analysis and distributional analysis we are confident in the ability of the proxy long run trend distribution mirroring the movements of the unobservable true long run trend (mean, variance). Analysis focuses on discovery of imbalances or non-congruences between the long run trend (proxy) mean and the realized daily trend. When an imbalance or non-congruence is detected, the next day price trend will move in the direction to correct with over correction a distinct possibility.

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[7] It is noteworthy that information not contained in close prices does affect realized trend predictions but are not accounted for in modeling process since the impact has not been impounded into close prices e.g. firm specific or general economic news events after market close.

Mean-variance tracking over time is accomplished using data fields 10 and 11. Field 10 contains the standard deviation of the proxy for long run trend and field 11 contains the proxy for the long run trend mean. Performance of mean-variance prediction versus realized daily trend is stored in field 9.

In Exhibit 1, long run trend proxy indicates flat trend of 1.0 from Feb. 19 to Feb. 20, 2020. On Feb. 19, 2020 mean-variance performance tracking indicates a close price of $ 323.52 with 1.0148 realized trend which was associated with long run trend (proxy) distribution with mean 0.998 and standard deviation of 1.0. The realized trend of 1.0148 as compared to 0.998 is "not in full congruence" and a correction of lower trend would be more congruent with 0.998 long run mean. The close price of $ 320.30 on the next trade-day Feb. 20, 2020 corresponds to realized trend of 0.989 which is congruent with 0.998 long run mean. Notice that as of Feb. 20, 2020 the long run mean-variance distribution has moved to a new mean of 0.97 and standard deviation unchanged at approximately 1.0. From this information the next trade-day trend is expected to be negative. **A long run (proxy) trend of 0.97 is an affirmative warning of drawn down due to suddenness and magnitude.**

TRI-SIGNAL has an animation feature that shows mean-variance, realized trend movement over last 10 trade-days which gives sense distribution movement in mean-variance space. Static mean-variance tracking graph is shown in Exhibit 4.

Tracking mean-variance performance over time is visualized on Exhibit 4. As an example, the July 21, 2020 close price was $ 388.00 with realized trend of 0.9862 which is congruent with being generated from a long run trend distribution with mean 0.99796 and standard deviation of 1.0018. On August 10, 2020, an imbalance is detected with close price of $ 450.91 with daily trend of 1.01453 generated from a long run trend centered at 1.00267 with standard deviation 1.00. Market forces will correct the imbalance by moving price downwards on August 11,2020 which did occur with close price of $ 437.30. Series {1,3} predictive signals and mean-variance tracking supported a prediction of next trade-day downward price which could have been used to profit in a short strategy. Price was predicted to fall due to short run non congruence and not due to long term trend forecast deterioration since long run trend was 1.00267 to august 11, 2020 which is great than 1.00.

For DJIA and SP500 Portfolios, predictive rules are color encoded in form of a heat map
The DJIA index will be used for demonstration purposes via 27 stock sub sample for period Jan 2 thru Aug. 10, 2020. Rows contain stock information and columns trade-date close price and predictive encoding for next trade-day. Exhibit 5 below shows the 27 stocks with no predictive signal buy/sell encoding. With no predictive buy/sell encoding a buy and hold strategy is optimal.
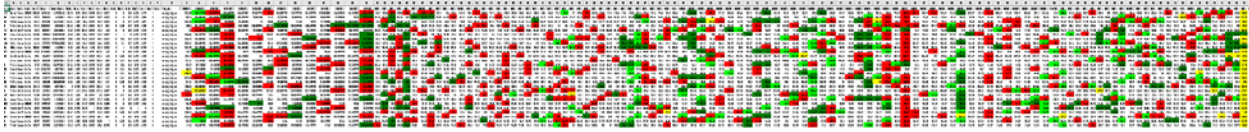
Exhibit 5

Exhibit 6

Exhibit 6 shows predictive buy/sell encoding supporting optimal investment return efficiency. Dark green indicates joint long run and short run buy. Light green indicates short run buy. Red indicates sell. Yellow indicates monitor. Buy stocks expected to increase and sell stocks expected to decrease if owned or short stocks expected to decrease. The predictive encoding clearly shows it is not optimal to use a buy and hold passive strategy no matter how low the cost. **Active return management using TRI-SIGNAL avoids drawdowns or mitigates effect to 1 – 2 trade-days while matching or outperforming passive strategies.**

	Stock_	Compa	Sector:	Colum	Trade_date:	2/19/20	2/20/20	2/21/20	2/24/20
2	MSFT	Microsoft	Technolog		current_stock_price:	187.279999	184.419998	178.589996	170.889999
24	CVX	Chevron C	Energy Mi		current_stock_price:	110.739998	109.809998	109.010002	104.709999
46	NKE	NIKE Inc.	Consumer		current_stock_price:	102.459999	102.529999	100.25	95.910004
68	BA	The Boein	Electronic		current_stock_price:	338.299988	336.279999	330.380005	317.899994
90	MRK	Merck & C	Health Tec		current_stock_price:	82	82.489998	82.339996	81.330002
112	CAT	Caterpillar	Producer		current_stock_price:	136.860001	136.929993	137.210007	132.169998
134	AXP	American	Finance		current_stock_price:	136.929993	136.580002	134.899994	128.190002
156	MMM	3M Co.	Producer		current_stock_price:	159.339996	158.559998	156.929993	152.550003
178	JPM	JPMorgan	Finance		current_stock_price:	137.490005	137.490005	135.809998	132.160004
200	INTC	Intel Corp	Electronic		current_stock_price:	67.110001	65.449997	64.339996	61.759998
222	UNH	UnitedHea	Health Ser		current_stock_price:	305.309998	302.130005	301.429993	277.790009
244	V	Visa Inc.	Finance		current_stock_price:	213.309998	211.449997	208.809998	198.789993
266	KO	The Coca-(	Consumer		current_stock_price:	59.77	59.720001	60.130001	58.650002
288	XOM	Exxon Mol	Energy Mi		current_stock_price:	60.34	59.860001	59.130001	56.360001
310	PG	Procter &	Consumer		current_stock_price:	125.440002	126.580002	126.699997	123.300003
332	GS	The Goldn	Finance		current_stock_price:	237.330002	232.729996	230.619995	224.539993
354	TRV	The Travel	Finance		current_stock_price:	134.509995	133.979996	135.160004	134.119995
376	MCD	McDonald	Consumer		current_stock_price:	215.630005	215.080002	215.869995	213.520004
398	HD	The Home	Retail Trac		current_stock_price:	243.639999	247.020004	245.339996	239.699997
420	WMT	Walmart I	Retail Trac		current_stock_price:	117.68	117.690002	118.580002	116.32
442	IBM	Internatio	Technolog		current_stock_price:	150.860001	151.220001	149.839996	146.429993
464	CSCO	Cisco Syst	Electronic		current_stock_price:	46.290001	46.849998	46.299999	44
486	PFE	Pfizer Inc.	Health Tec		current_stock_price:	36.23	35.849998	35.720001	34.669998
508	JNJ	Johnson &	Health Tec		current_stock_price:	148.940002	148.369995	149.929993	145.910004
530	AAPL	Apple Inc.	Electronic		current_stock_price:	323.619995	320.299988	313.049988	298.179993
552	VZ	Verizon C(	Communi(		current_stock_price:	58.220001	58.09	58.200001	57.990002
574	DIS	The Walt [	Consumer		current_stock_price:	141.300003	140.369995	138.970001	133.009995

Exhibit 7

Exhibit 7 shows the 27 DJIA stock sample ordered by highest return as predicted for August 11, 2020 prior to market open. Rows contain individual stock series. Columns contain market close prices. The other 21 rows of information are hidden for each stock.

Red highlighting indicates sell indicator and by close of Feb. 24, warning of DJIA index collapse commencing with market open Feb. 25, 2020 is predicted with high probability due to Cornv-19 pandemic. As prices fall, short run and long run buy indicators (dark green) increase in frequency since in normal markets this would otherwise be "buy" opportunities. There are interspersed short run buy indicators (light green) which also occur as prices fall. The speed of index declines and the necessary speed for an investor to act are noteworthy. Action was required within 2 – 3 trade days to avoid or mitigate losses. If no action taken by Feb. 26/27, 2020, DJIA investors had to decide to take losses or wait out the downdraw until normal markets returned. Most DJIA investors were forced to wait it out as the down draw was severe reaching -40% at peak.

	A	B	C	T	U	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
1	Stock	Compa	Sector	Colum	Trade_date:	3/6/20	3/9/20	3/10/20	3/11/20	3/12/20	3/13/20	3/16/20	3/17/20	3/18/20	3/19/20
2	MSFT	Microsoft	Technolog		current_stock_price:	161.570007	150.62	160.919998	153.630005	139.059998	158.830002	135.419998	146.570007	140.399994	142.710007
24	CVX	Chevron C	Energy Mi		current_stock_price:	95.32	80.67	84.980003	83.029999	76.260002	83.419998	69.699997	70.690002	55.049999	57.389999
46	NKE	NIKE Inc.	Consumer		current_stock_price:	88.360001	84.11	88.300003	84	74.199997	75.580002	66.790001	69.839996	68.040001	70.339996
68	BA	The Boein	Electronic		current_stock_price:	262.329987	227.17	231.009995	189.080002	154.839996	170.199997	129.610001	124.139999	101.889999	97.709999
90	MRK	Merck & C	Health Tec		current_stock_price:	82.199997	78.96	82.019997	79.25	74.449997	76.75	69.919998	74.480003	71.629997	70.730003
112	CAT	Caterpillar	Producer		current_stock_price:	121.410004	104.07	106.489998	100.690002	92.260002	99.639999	93.410004	100.199997	100.120003	103.010002
134	AXP	American	Finance		current_stock_price:	108.239998	98.29	103.300003	95.379997	83.529999	99.599998	85.870003	86.580002	73.75	77.07
156	MMM	3M Co.	Producer		current_stock_price:	153.649994	144.06	153.300003	147.240005	133.580002	141.679993	130.910004	134.440002	137.020004	137.509995
178	JPM	JPMorgan	Finance		current_stock_price:	108.080002	93.44	100.699997	95.959999	88.050003	103.910004	88.360001	93.760002	83.889999	85.300003
200	INTC	Intel Corp	Electronic		current_stock_price:	55.77	50.85	53.98	51.66	45.540001	54.43	44.610001	50.080002	47.610001	45.939999
222	UNH	UnitedHea	Health Ser		current_stock_price:	283.869995	273.44	280	277.779999	250.610004	272.040009	225.039993	244.220002	217.059998	219.800003
244	V	Visa Inc.	Finance		current_stock_price:	184.360001	171.13	182.600006	172.949997	160.080002	175.830002	152.009995	157.889999	148.479996	152.25
266	KO	The Coca-	Consumer		current_stock_price:	55.259998	51.86	53.66	52.209999	47.16	48.470001	45.259998	47.18	44.849998	41.830002
288	XOM	Exxon Mo	Energy Mi		current_stock_price:	47.689999	41.86	43.41	41.98	37.18	38.119999	34.490002	36.810001	33.119999	34.43
310	PG	Procter &	Consumer		current_stock_price:	121.660004	116.06	120.550003	111.589996	101.839996	114.07	108.5	118.239998	117.449997	110.830002
332	GS	The Goldn	Finance		current_stock_price:	192.850006	172.81	184.350006	173.889999	102.18	150.679993	177.169998	154.660004	158.669998	149.490005
354	TRV	The Travel	Finance		current_stock_price:	124.839996	116.2	119.57	112.599998	102.18	107.449997	85.099998	96.410004	81.690002	86.07
376	MCD	McDonald	Consumer		current_stock_price:	198.860001	186.86	199.860001	188.25	170.130005	177.130005	149.009995	147.619995	137.300003	149.5
398	HD	The Home	Retail Trac		current_stock_price:	228.509995	210.46	225.699997	212.889999	190.589996	205.669998	164.960007	173.639999	155.630005	161.130005
420	WMT	Walmart	Retail Trac		current_stock_price:	117.230003	117.16	119.790001	114.43	104.050003	114.099998	106.760002	119.260002	122.580002	119.449997
442	IBM	Internatio	Technolog		current_stock_price:	127.730003	117.81	124.769997	117.970001	102.809998	107.949997	99.080002	106.650002	103.550003	100.339996
464	CSCO	Cisco Syst	Electronic		current_stock_price:	39.68	37.96	40.080002	37.049999	33.200001	37.639999	33.709999	35.5	37.119999	37.709999
486	PFE	Pfizer Inc.	Health Tec		current_stock_price:	35.02	33.76	34.59	32.169998	30.02	32.709999	30.15	32.16	32.360001	30.42
508	JNJ	Johnson &	Health Tec		current_stock_price:	142.029999	136.44	141.639999	131.800003	125.410004	134.289993	127.129997	136.589996	134.960007	127.050003
530	AAPL	Apple Inc.	Electronic		current_stock_price:	289.029999	266.17	285.339996	275.429993	248.229996	277.970001	242.210007	252.860001	246.669998	244.779999
552	VZ	Verizon C	Communic		current_stock_price:	56.869999	55.83	56.52	54.830002	51.200001	54.169998	50.990002	54.310001	54.32	53.619999
574	DIS	The Walt [	Consumer		current_stock_price:	115.269997	104.35	111.459999	105.510002	91.809998	102.519997	95.010002	93.529999	88.800003	94.93

Exhibit 8

By market close March 16, 2020 the DJIA index was starting to position for recovery as indicated by numerous buy indications. Individual stocks were not at the lowest price point but were approaching and some were already in the neighborhood. (See Exhibit 8.)

Exhibit 9:

Stock_	Compa	Sector	Colum	Trade_date:	5/7/20	5/8/20	5/11/20	5/12/20	5/13/20	5/14/20	5/15/20	5/18/20	5/19/20	5/20/20	5/21/20
MSFT	Microsoft	Technolog		current_stock_price:	183.600006	184.679993	186.740005	182.51	179.75	180.53	183.16	184.91	183.63001	185.66	183.42999
CVX	Chevron C	Energy Mi		current_stock_price:	92.639999	95.470001	93.370003	91.099998	88.699997	90.050003	89.160004	92.550003	89.620003	93	92.040001
NKE	NIKE Inc.	Consumer		current_stock_price:	88.559998	90.459999	90.93	88.260002	86.019997	86.550003	86.989998	91.040001	91.510002	92.949997	94.260002
BA	The Boein	Electronic		current_stock_price:	128.649994	133.440002	128.910004	125.22	121.5	122.52	120	135.44	130.44	133.32001	139
MRK	Merck & C	Health Tec		current_stock_price:	75.599998	76.400002	77.910004	77.190002	77.889999	80.050003	79.779999	79.720001	77.550003	76.889999	76.550003
CAT	Caterpillar	Producer		current_stock_price:	107.290001	112.110001	108.610001	105	104.48	106.19	107.92	115.02	112.08	115.69	114.06
AXP	American	Finance		current_stock_price:	86.730003	89.5	85.330002	83.139999	78.029999	83.809998	82.220001	88.410004	87.260002	90.730003	89.830002
MMM	3M Co.	Producer		current_stock_price:	145.740005	148.509995	145.729996	141.52	136.12	135.99001	138.69	149.27	148.38001	148.38001	145.81
JPM	JPMorgan	Finance		current_stock_price:	91.209999	92.699997	89.970001	87.029999	84.029999	87.519997	85.900002	90.449997	88.669998	91.330002	90.169998
INTC	Intel Corp	Electronic		current_stock_price:	59.169998	59.669998	60.130001	58.389999	57.740002	59.080002	58.279999	59.919998	60.290001	63.099998	61.98
UNH	UnitedHea	Health Ser		current_stock_price:	285	288.690002	288.690002	287.70001	278	290.60999	290.95999	293.35999	289.04999	287.98999	286.91
V	Visa Inc.	Finance		current_stock_price:	182.720001	185.089996	183.559998	179.47	177.09	180.89999	183.49001	191.38001	189.36	193.86	190.62
KO	The Coca-	Consumer		current_stock_price:	44.599998	46.110001	45.540001	44.82	43.939999	43.700001	43.259998	44.970001	44.540001	45.889999	45.169998
XOM	Exxon Mo	Energy Mi		current_stock_price:	44.240002	46.18	45.740002	44.119999	41.93	42.299999	42	45.34	43.939999	45.369999	44.560001
PG	Procter &	Consumer		current_stock_price:	112.169998	115.949997	115.309998	114.55	113.92	113.81	114.61	116.21	112.44	113.28	111.62
GS	The Goldn	Finance		current_stock_price:	182.320007	185.389999	177.21001	171.8	174.45	171.87	181.88001	177.83	181.44	180.10001
TRV	The Travel	Finance		current_stock_price:	95.800003	97.339996	95.510002	93.959999	89.860001	90.220001	90.309998	95.300003	93.269997	95.540001	99.169998
MCD	McDonald	Consumer		current_stock_price:	181.119995	181.229996	180.880005	176.53999	172.82001	175.41	173.81	179.83	179.57001	184.10001	185.08
HD	The Home	Retail Trad		current_stock_price:	229.449997	234.429993	236.559998	232.89999	230.10001	234.48	239.33	245.35001	238.10001	238.19	240.88001
WMT	Walmart I	Retail Trad		current_stock_price:	121.889999	122.940002	123.669998	123.78	123.71	123.42	125.94	127.66	124.95	125.45	124.99
IBM	Internatio	Technolog		current_stock_price:	121.230003	122.989998	122.589996	120.26	115.73	116.95	116.98	121.56	120.29	121.38	119.12
CSCO	Cisco Syst	Electronic		current_stock_price:	41.369999	42.990002	43.32	43.220001	41.950001	43.849998	44.27	45.060001	44.610001	45.439999	44.639999
PFE	Pfizer Inc.	Health Tec		current_stock_price:	36.959999	37.220001	38.099998	37.360001	37.049999	37.919998	37.759998	38.07	37.68	37.630001	37.259998
JNJ	Johnson &	Health Tec		current_stock_price:	147.589996	148.699997	149.110001	147.14	147.13001	147.64	150.44	150.52	149.02	147.67999	146.71001
AAPL	Apple Inc.	Electronic		current_stock_price:	303.73999	310.130005	315.01001	311.41	307.64999	309.54001	307.70999	314.95999	313.14002	319.23001	316.85001
VZ	Verizon Cc	Communic		current_stock_price:	55.580002	57	56.400002	55.459999	54.849998	54.91	54.709999	55.720001	54.380001	54.259998	53.970001
DIS	The Walt I	Consumer		current_stock_price:	105.57	109.160004	107.769997	104.56	102.92	105.91	109.05	116.85	114.37	119.92	117.83

Exhibit 9

By mid-May, the prevalence of buy indication signals for DJIA index recovery starting from the neighborhood of lowest price points.(See Exhibit 9.)

Stock_	Compa	Sector	Column	Trade_date:	6/8/20	6/9/20	6/10/20	6/11/20	6/12/20
MSFT	Microsoft	Technolog		current_stock_price:	188.36	189.8	196.84	186.27	187.74001
CVX	Chevron C	Energy Mi		current_stock_price:	103.24	101.53	97.580002	89.370003	92.389999
NKE	NIKE Inc.	Consumer		current_stock_price:	104.29	102.63	102.12	95.169998	96.43
BA	The Boein	Electronic		current_stock_price:	230.5	216.74001	203.41	170	189.51
MRK	Merck & C	Health Tec		current_stock_price:	82.900002	82.260002	81.769997	77.349998	76.300003
CAT	Caterpillar	Producer		current_stock_price:	137.72	134.19	132.44	121.55	123.15
AXP	American	Finance		current_stock_price:	113.67	110.46	106.16	98.599998	101.68
MMM	3M Co.	Producer		current_stock_price:	166.87	166.7	163.89999	152.38001	154.87
JPM	JPMorgan	Finance		current_stock_price:	113.45	110.54	106.06	97.209999	99.870003
INTC	Intel Corp	Electronic		current_stock_price:	63.669998	63.040001	63.869999	59.700001	59.330002
UNH	UnitedHea	Health Ser		current_stock_price:	309.48001	309.20999	305.75	283.73001	285.14999
V	Visa Inc.	Finance		current_stock_price:	199.60001	199.08	200.48	188.88001	192.26
KO	The Coca-	Consumer		current_stock_price:	49.849998	49	48.619999	45.540001	45.599998
XOM	Exxon Mo	Energy Mi		current_stock_price:	54.740002	53.52	50.650002	46.18	47.169998
PG	Procter &	Consumer		current_stock_price:	119.05	118.34	119.23	116.26	115.62
GS	The Goldn	Finance		current_stock_price:	220.81	218.10001	213.52	194.13001	201.78
TRV	The Travel	Finance		current_stock_price:	128	125.42	120.98	110.55	113.33
MCD	McDonald	Consumer		current_stock_price:	202.64999	199.52	195.8	187.51	189.17
HD	The Home	Retail Trad		current_stock_price:	256.76999	256.76001	254.45	239.47	242.45
WMT	Walmart I	Retail Trad		current_stock_price:	121.24	121.35	121.16	120.09	117.74
IBM	Internatio	Technolog		current_stock_price:	135.75	131.87	129.87	118.01	121.91
CSCO	Cisco Syst	Electronic		current_stock_price:	48.130001	48.049999	47.419998	43.669998	45.07
PFE	Pfizer Inc.	Health Tec		current_stock_price:	36.59	36.209999	35.919998	33.299999	33.75
JNJ	Johnson &	Health Tec		current_stock_price:	146.77	145.96001	147.8	140.87	142.14999
AAPL	Apple Inc.	Electronic		current_stock_price:	333.45999	343.98999	352.84	335.89999	338.79999
VZ	Verizon Cc	Communic		current_stock_price:	58.09	57.860001	58.049999	56.450001	56.529999
DIS	The Walt I	Consumer		current_stock_price:	127.28	123.89	122.18	112.64	115.49

Exhibit 10

By close of market June 9, 2020 warning of second DJIA major drawdown is shown. Confirmation occurred within two trade days. (See Exhibit 10.)

Exhibit 11

	A	B	T	U	DS 7/14/20	DT 7/15/20	DU 7/16/20	DV 7/17/20	DW 7/20/20	DX 7/21/20	DY 7/22/20	DZ 7/23/20	EA 7/24/20
1	Stock_symb	Company_name	Colum	Trade_date:	7/14/20	7/15/20	7/16/20	7/17/20	7/20/20	7/21/20	7/22/20	7/23/20	7/24/20
2	MSFT	Microsoft Corp.		current_stock_price:	208.350006	208.039993	203.919998	202.880005	211.600006	208.75	211.75	202.539993	201.300003
24	CVX	Chevron Corp.		current_stock_price:	88.349998	88.889999	88.360001	87.190002	85.269997	91.389999	91.040001	91.010002	90.129997
46	NKE	NIKE Inc.		current_stock_price:	96.760002	98.540001	97.260002	96.279999	95.650002	98.360001	98.910004	98.300003	98.43
68	BA	The Boeing Co.		current_stock_price:	179.960007	187.940002	178.699997	175.660004	174.419998	178.630005	179.789993	176.449997	173.759995
90	MRK	Merck & Co. Inc.		current_stock_price:	78.25	79.440002	79.400002	79.870003	79.410004	78.889999	78.779999	78.059998	77.099998
112	CAT	Caterpillar Inc.		current_stock_price:	136.880005	138.360001	138.559998	136.899994	134.630005	135.869995	136.979996	136.600006	137.580002
134	AXP	American Express C		current_stock_price:	94.839996	97.360001	96.32	95.18	94	96.330002	96.540001	96.669998	95.330002
156	MMM	3M Co.		current_stock_price:	158.539993	159.330002	160.5	159.830002	156.369995	157.800003	158.710007	159.289993	159.839996
178	JPM	JPMorgan Chase &		current_stock_price:	98.209999	99.730003	100.010002	98.160004	97.300003	99.410004	98.690002	98.980005	98.279999
200	INTC	Intel Corp.		current_stock_price:	58.98	59.029999	59.139999	60	61.150002	60.700001	61.049999	60.400002	50.59
222	UNH	UnitedHealth Grou		current_stock_price:	308.519989	304.070007	307.149994	306.529999	303.459991	305.109985	306.709991	302.970001	300.790009
244	V	Visa Inc.		current_stock_price:	193.330002	196.550003	193.5	195.089996	198.470001	196.479996	198.860001	197.429993	195.149994
266	KO	The Coca-Cola Co.		current_stock_price:	45.869999	46.400002	46.150002	46.82	46.119999	47.200001	48.48	48.279999	48.490002
288	XOM	Exxon Mobil Corp.		current_stock_price:	44.07	44.630001	44.279999	43.52	42.5	44.650002	43.610001	43.700001	43.43
310	PG	Procter & Gamble C		current_stock_price:	125.089996	124.5	124.760002	125.629997	125.239998	125.07	126.139999	126.160004	125.959999
332	GS	The Goldman Sachs		current_stock_price:	214.009995	216.899994	214.669998	211.410004	211.710007	212.020004	206	203.020004	201.470001
354	TRV	The Travelers Cos. I		current_stock_price:	118.550003	119.139999	120.5	119.160004	118.769997	120.419998	122.239998	118.610001	118.279999
376	MCD	McDonald's Corp.		current_stock_price:	190.720001	191.770004	190.919998	191.479996	191.610001	192.979996	198.619995	197.550003	198.720001
398	HD	The Home Depot In		current_stock_price:	257.790009	257.799988	258.079987	260.380005	260.170013	262.420013	265.170013	263.809998	265.309998
420	WMT	Walmart Inc.		current_stock_price:	132.009995	132	132.199997	131.740005	131.470001	132.330002	132.660004	131.639999	131.240005
442	IBM	International Busine		current_stock_price:	120.599998	123	124.010002	125.110001	126.370003	126.059998	128.669998	127.330002	125.790001
464	CSCO	Cisco Systems Inc.		current_stock_price:	46.259998	46.400002	45.779999	46.75	46.970001	47.02	46.900002	47.41	46.400002
486	PFE	Pfizer Inc.		current_stock_price:	35.23	35.720001	35.599998	36.25	36.5	36.689999	38.560001	38.41	37.66
508	JNJ	Johnson & Johnson		current_stock_price:	147.919998	148.259995	149.25	149.350006	149.350006	149.740005	150.009995	149.610001	148.119995
530	AAPL	Apple Inc.		current_stock_price:	388.230011	390.899994	386.089996	385.309998	393.429993	388	389.089996	371.380005	370.459991
552	VZ	Verizon Communica		current_stock_price:	55.439999	55.060001	55.779999	56.299999	55.869999	55.84	55.75	55.849998	56.849998
574	DIS	The Walt Disney Co		current_stock_price:	118.660004	120.900002	119.43	118.650002	117.790001	118.620003	119.029999	118.120003	117.610001

Exhibit 11

Numerous buy indications occurred July 14 thru July 24 for indivual stocks within DJIA index. The set of stocks expected to increase achieved a higher gain than holding the entire DJIA index for the period. (See Exhibit 11.)

1	Stock_symb	Company_name	Colum	Trade_date:	8/6/20	8/7/20	8/10/20
2	MSFT	Microsoft Corp.		current_stock_price:	216.350006	212.479996	208.25
24	CVX	Chevron Corp.		current_stock_price:	87.470001	86.800003	89.730003
46	NKE	NIKE Inc.		current_stock_price:	100.449997	101.860001	105.410004
68	BA	The Boeing Co.		current_stock_price:	172.199997	170.020004	179.410004
90	MRK	Merck & Co. Inc.		current_stock_price:	81.050003	81.019997	80.910004
112	CAT	Caterpillar Inc.		current_stock_price:	134.389999	134.919998	142.020004
134	AXP	American Express C		current_stock_price:	95.919998	99.160004	101.620003
156	MMM	3M Co.		current_stock_price:	156	158.330002	161.440002
178	JPM	JPMorgan Chase &		current_stock_price:	97.239998	99.379997	100.639999
200	INTC	Intel Corp.		current_stock_price:	48.57	48.029999	49.220001
222	UNH	UnitedHealth Grou		current_stock_price:	314.059998	317.029999	319.100006
244	V	Visa Inc.		current_stock_price:	198.770004	196.360001	196.789993
266	KO	The Coca-Cola Co.		current_stock_price:	47.48	47.799999	47.720001
288	XOM	Exxon Mobil Corp.		current_stock_price:	43.639999	43.439999	44.509998
310	PG	Procter & Gamble C		current_stock_price:	132.710007	133.550003	134.100006
332	GS	The Goldman Sachs		current_stock_price:	204.25	208.270004	209.380005
354	TRV	The Travelers Cos. I		current_stock_price:	113.739998	117.360001	119.120003
376	MCD	McDonald's Corp.		current_stock_price:	203.179993	204.600006	204.119995
398	HD	The Home Depot In		current_stock_price:	269.369995	271.640015	274.730011
420	WMT	Walmart Inc.		current_stock_price:	129.350006	129.970001	131.880005
442	IBM	International Busine		current_stock_price:	126.120003	124.959999	127.110001
464	CSCO	Cisco Systems Inc.		current_stock_price:	47.77	47.43	47.73
486	PFE	Pfizer Inc.		current_stock_price:	38.27	38.450001	38.389999
508	JNJ	Johnson & Johnson		current_stock_price:	147.550003	148.600006	148.029999
530	AAPL	Apple Inc.		current_stock_price:	455.609985	444.450012	450.910004
552	VZ	Verizon Communica		current_stock_price:	57.830002	58.529999	58.990002
574	DIS	The Walt Disney Co		current_stock_price:	130.820007	129.929993	128.789993

Exhibit 12

As seen in Exhibit 12, there are two buy indications: Catepillar (CAT) at $ 142.02 and JP Morgam (JPM) at $ 100.64 for prior to market open August 11, 2020.

Let's check these two stocks and see how they performed. Both stocks are reporting significant gains as of 2:15 p.m. August 11, 2020 that are profitable even after netting of transaction costs. (See Exhibit 13.)
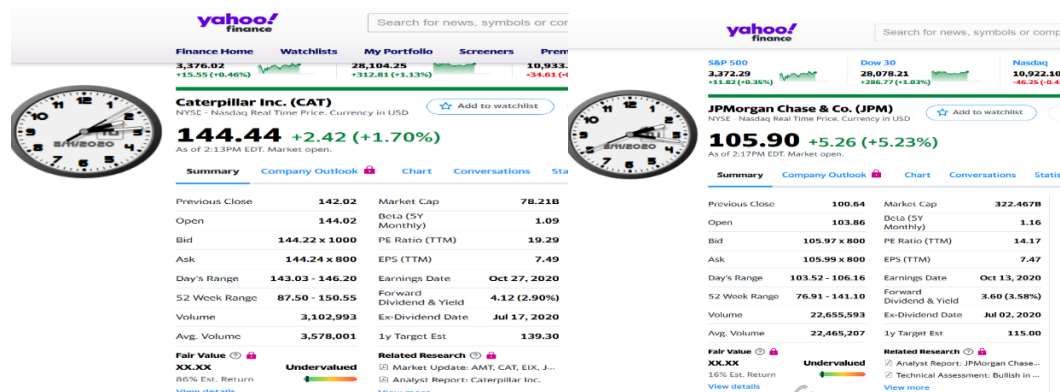

Exhibit 13

Results: Predictive Equity Portfolio Returns for 2020, 2019 – DJIA and SP500

Perdictive equity results for DJIA for years 2020 and 2019 follow below. For SP500 predictive equity results, see Appendix.

Portfolio were formed dynamically based on price for dark green and light green encodings for selected trade-days. Each trade was 1 day duration with forced liquidation. Gross returns were used for illustrative purposes. TRI-SIGNAL predictive equity return for 2020 is signifciantly superior: YTD DJIA return 32%+, YTD SP500 return 19%+. See Exhibits 14 and 16. For 2019 TRI-SIGNAL returned, YTD DJIA = 12%+ and YTD SP500 = 16%.

Fund managers using TRI-SIGNAL are expected to avoid drawdowns and match or beat benchmarks (almost surly in probability sense) with positive returns due to predictive $\{P\}$ filtering of next trade-day expected daily trend distribution.

Comparison of 2020 YTD Gross Returns for TRI-SIGNAL Predictive DJIA vs DJIA ending Aug. 10
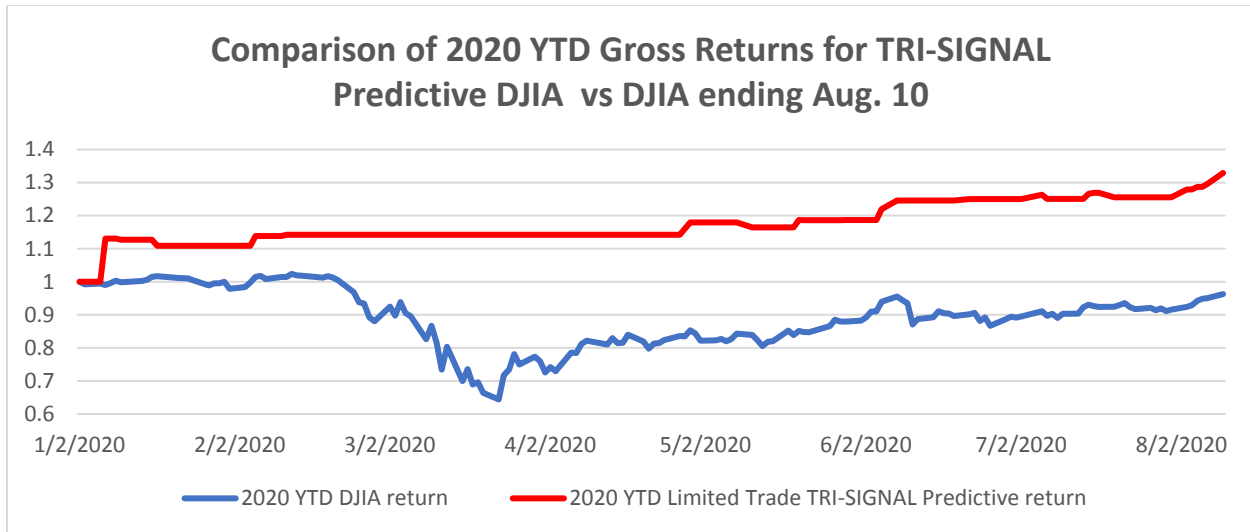
Exhibit 14

TRI-SIGNAL predictive DJIA YTD return is generally a non-decreasing step function with 32%+ return as of close Aug. 10,2020 while YTD DJIA daily return is approximaely -4%. Peak YTD DJIA return was in the neighborhood of -40%. Minimum dynamic diversificaton rule of 3 or more stocks on any trade day was used . All trades were 1 trade-day duration with forced termination regardless if stock continued to increase.

Analysis of return trend histograms supporting 2020 DJIA YTD return ending Aug. 10 explains the significant performance difference. Remember the 23 trade-day TRI-SIGNAL predictive equity trend distribution is contained within the full 153 trade-day daily trend distribution. $\{P\}$ filtering yielded a distribution with greater investment efficiency in the sense of large kurtosis, skew to right and a mean of 1.013 using only 23 trade-days. The distribution has majority of mass from 1 onwards with an additional positive outlier which overcomes the small negative masses located from 0.985 to 0.995. See Exhibit 15.

The 153 trade-day SP500 daily trend distribution has mean of 1.0002, negative skew and large kurtosis with more left tail mass on values less than 0.97 which results in YTD return of – 3.8%. See Exhibit 16.

2020 DJIA Predictive Trend ending Aug. 10, 23 Trade days, YTD= 32.9%, Mean: 1.013, Stddev: 0.029, Sharpe: 35.2, Skew: 3.24, Kurtosis: 13.3
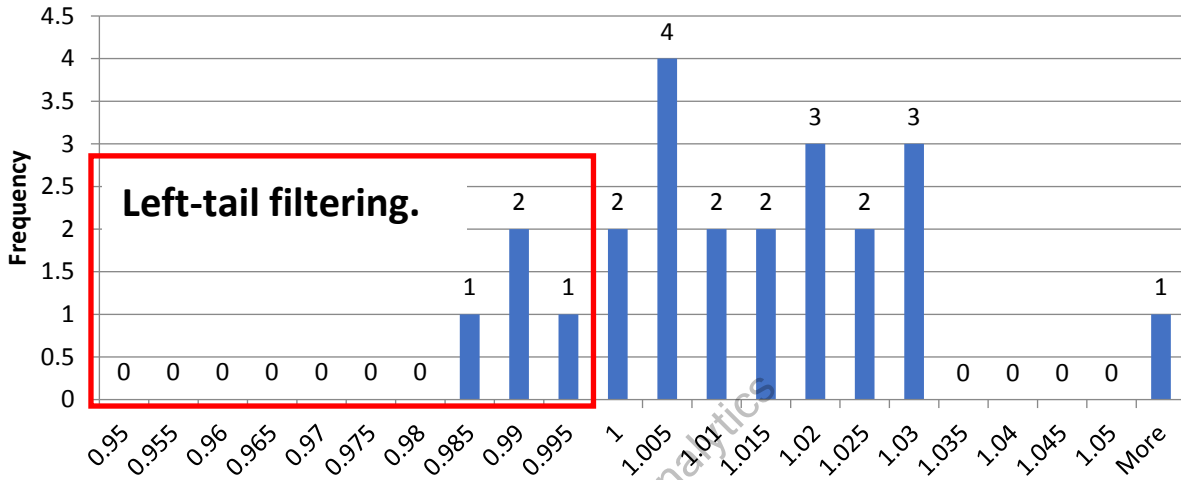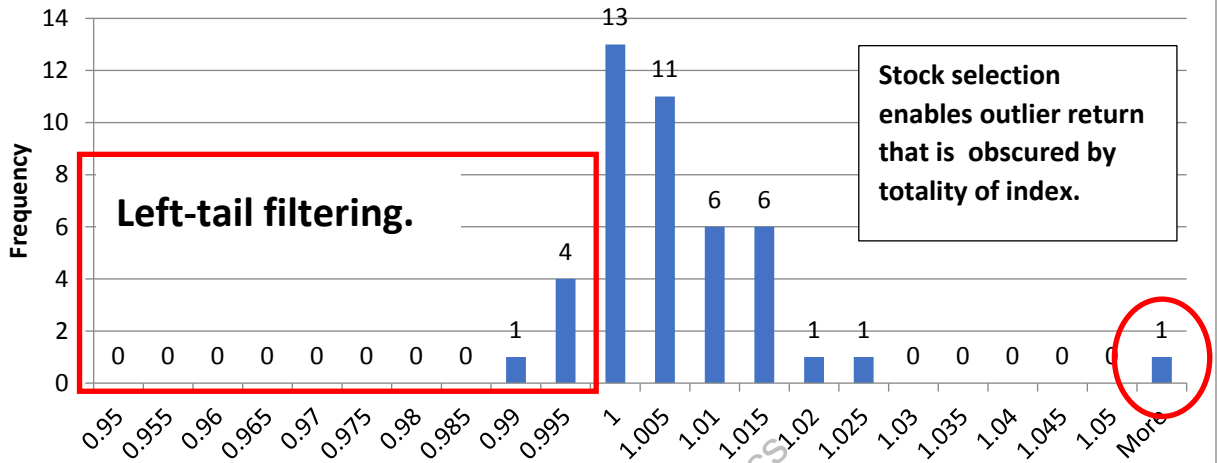

Exhibit 15

2020 DJIA Daily Trend ending Aug. 10, 153 Trade days, YTD= -3.8%, Mean: 1.0002, Stddev: 0.028, Sharpe: 35.1, Skew: -0.37, Kurtosis: 5.42
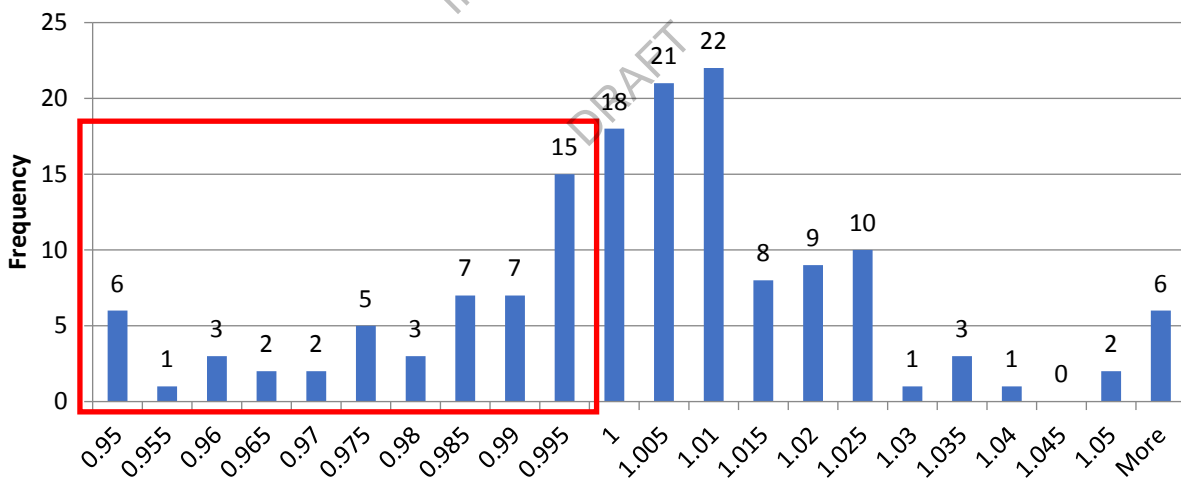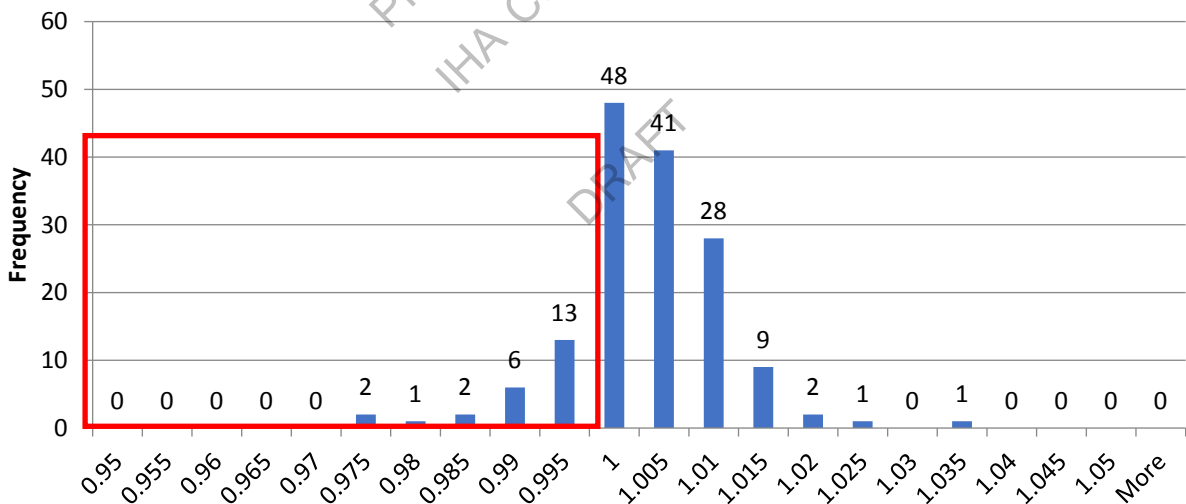

Exhibit 16

2019 was a bull market and the DJIA was up significantly. Predictive equity by design will select fewer stocks than contained within an index. When the majority of stocks are increasing with the market, predictive equity return will increase but not as fast due to fewer contributing stocks. When the mix of index stocks contains stocks moving up and moving down, predictive equity return will be higher than the index. Each situation is seen in Exhibit 17. In the long run, predictive equity return will be higher but for short, temporary durations the index return will be higher as expected. A fund manager using TRI-SIGNAL is able to avoid drawdowns and have returns that match or are higher than the index. It is unlikely the fund manager would perform significantly below the index or benchmark. Predictive equity return used forced 1 trade-day duration and an investment manager would let stocks that continued to increase accrue move gain. As of Aug. 10, YTD predictive equity return was 12.6% vs YTD DJIA of 10.9%.
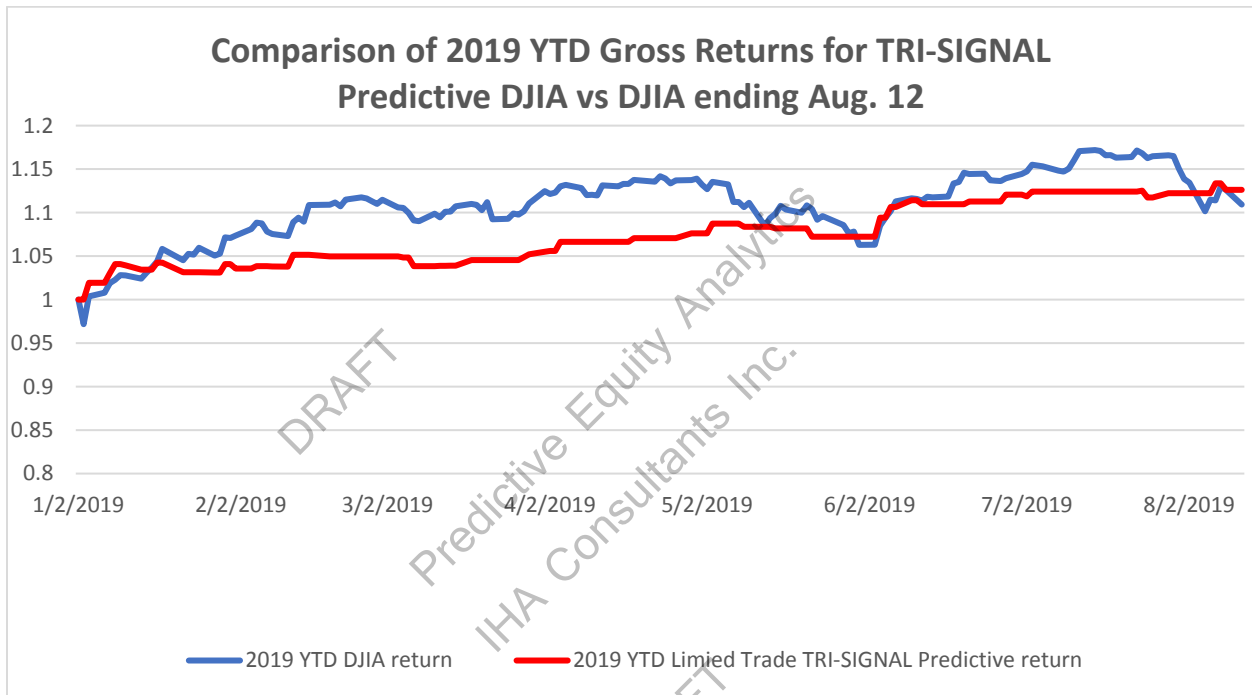
Exhibit 17

The predictive equity distribution has two small point masses on 0.99 and 0.995 with all other mass from 1.0 onwards. Skew to right of 5.12 and large kurtosis pf 55.6 and mean = 1.005. $\{P\}$ filtering by way of stock selection using predictive rules created 1 large positive outlier that is not seen in daily trend distribution. The daily trend distribution for the trade-day of interest contained the outlier but had many negative return stocks. See Exhibits 18 and 19. The daily trend distribution has slight negative skew with mean = 1.0007 and YTD return of 10.9%

2019 DJIA Predictive Trend ending Aug. 12, 44 Trade days, YTD = 12.6%, Mean: 1.005, Stddev: 0.018, Sharpe: 55.6, Skew: 5.12, Kurtosis: 55.6

Stock selection enables outlier return that is obscured by totality of index.

Left-tail filtering.

Exhibit 18

2019 DJIA Daily Trend ending Aug. 12, 155 Trade days, YTD = 10.9%, Mean: 1.0007, Stddev: 0.008, Sharpe: 124.1, Skew: -0.32, Kurtosis: 3.32

Exhibit 19

Equity Portfolio Mean-Variance Dominance and Dynamic Diversification
Optimal portfolio is constructed using predictive rules to identify stocks expected to increase and those expected to decrease. We start not from an initial position of holding a diversified portfolio rather from a portfolio consisting of 100% cash. Purchasing stocks expected to increase using a minimum rule of say at least 3 to 5 or more is referred to as dynamic diversification. Funds achieve maximal return efficiency under dynamic diversification at lowest risk which enables equity portfolio mean-variance dominance. Buy and hold strategies are needed when there is no predictive capability. The downside of buy and hold strategies is up-front cost and the fact that funds allocated to stocks sacrifice return in order to gain breath of trend contribution – good or bad. Dynamic diversification allocates funds only to the set of stocks expected to increase which increases likelihood of positive return contribution.

Additional return can be achieved by shorting stocks expected to decrease. By holding cash and a portfolio of stocks expected to increase in value 100% investment efficiency is achieved. By holding cash, stocks expected to increase and shorting stocks expected to decrease investment efficiency in excess of 100% is attainable.

Compounding of Investment Gains
By design predictive equity analytics seeks to capture short run and long run gains with the emphasis on short run. As gains are realized they are used for subsequent investment along with any new capital. Re-investment can be net of tax liability or gross with tax liability calculated at year end. Availability of compounding of investment realized gains further boosts investment efficiency.

Incorporating tax effects as last element hinders investment efficiency since artificially imposed holding period durations over which stock price direction prediction is not likely to hold results in sub-optimal investment efficiency.

Long run Return Forecasting
Market consensus of the long run prospects for any stock price can be formed by tracking the movement of a stock's moving geometric average long run mean proxy values. Whenever the geometric average exceeds 1.0 and maintains >1.0 for some amount of time, the market consensus long run outlook for the stock is price appreciation. The degree of expected appreciation is the difference of the moving geometric average minus 1.0. Similarly, whenever the moving geometric average is below 1.0 and remains there for some amount of time, the market consensus long run outlook for the stock is price drawdown.

Dimensions of Investment Efficiency
Investment efficiency captures the largest gain for smallest amount of risk with many favorable opportunities as possible over the shortest future time period with reinvestment of realized gains all while maintaining dynamic diversification. TRI-SIGNAL enables all dimensions of investment efficiency.

Conclusion

Predictive equity analytics filtering to remove or substantially remove left tail risk results in positive returns and avoids drawdowns. Can a portfolio be crisis proofed? Yes, at no additional cost and requiring no additional instruments. We demonstrated that predictive equity analytics applied to DJIA and SP500 for 2020 and 2019 avoided drawdowns and reported significantly superior results regardless of market conditions. Predictive equity analytics positive filtering enables dynamic diversification and puts every dollar to work earning return at reduced risk levels. 60%/40% diversification is no longer optimal when using predictive equity analytics. Optimal stock selection, timing and bid price are now known prior to market open using predictive equity analytics. We showed predictive equity analytics enables mean-variance dominance of returns.

Practical applications of predictive equity analytics include hedging for life insurers, pension fund yield enhancement, ETF/mutual fund yield boosting and optimal returns for hedge funds.

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Appendix: SP500 Index

Comparison of 2020 YTD Gross Returns for TRI-SIGNAL Predictive SP500 vs SP500 ending Aug. 10
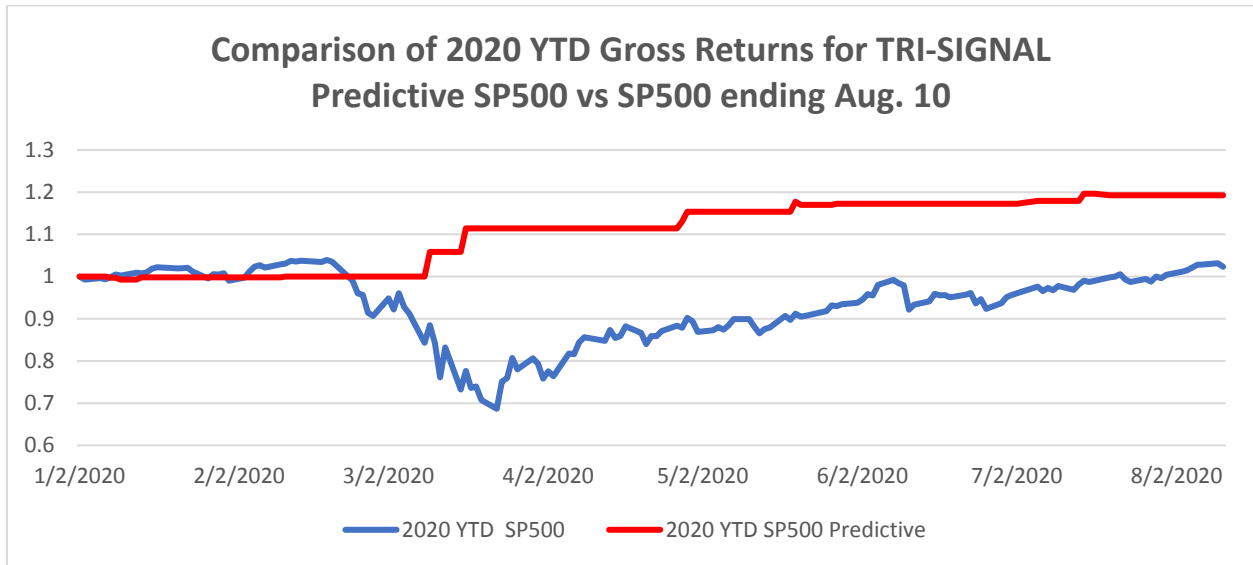
Exhibit 20

Predictive equity analytics 2020 SP500 YTD return thru Aug. 10 was 19.3% vs SP500 Daily Return of 2.3%. (See Exhibit 20.) The predictive equity trend distribution is mean-variance dominant (mean = 1.01, stddev= 0.020) over the daily return distribution (mean = 1.0005, stddev= 0.026). Comparing Exhibits 21 and 22, the positive filtering removed virtually the entire left tail except for a single observation of 0.995 with probability 0.07.

2020 SP500 Predictive Trend ending Aug. 10, 15 Trade days, YTD= 19.3%, Mean: 1.01, Stddev: 0.020, Sharpe: 50.8, Skew: 1.58, Kurtosis: 1.81
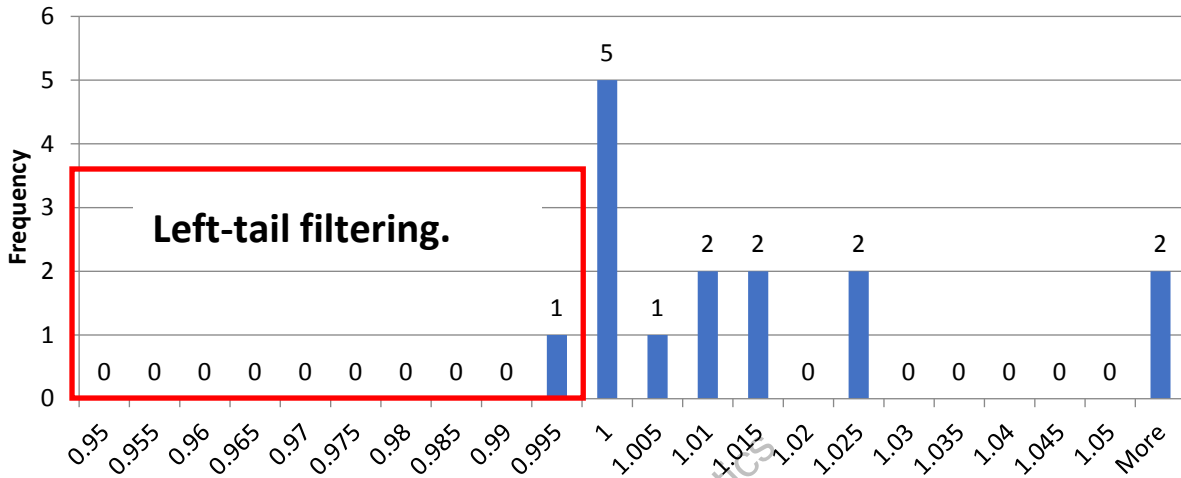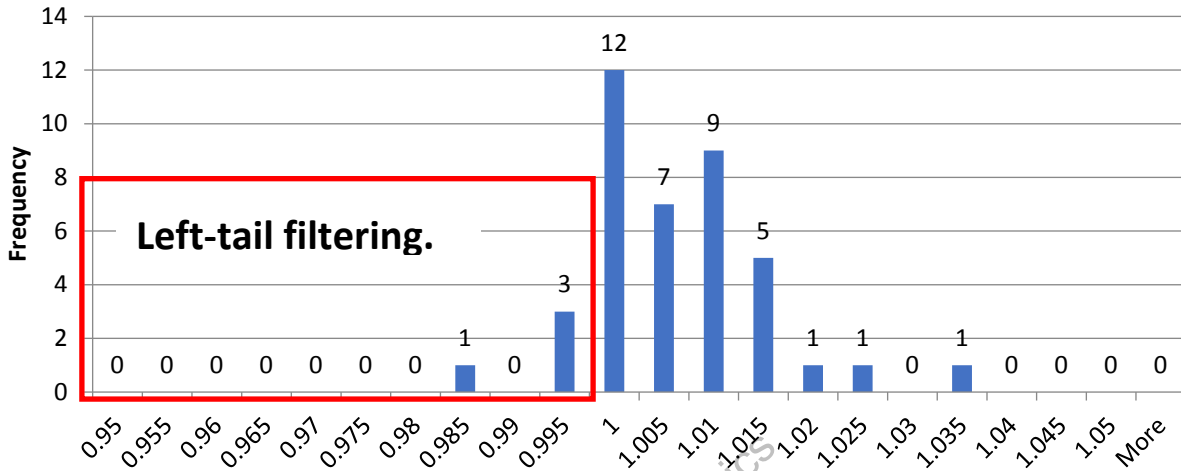

Exhibit 21

2020 SP500 Daily Trend ending Aug. 10, 153 Trade days, YTD= 2.3%, Mean: 1.0005, Stddev: 0.026, Sharpe: 37.8, Skew: -0.44, Kurtosis: 5.27

Exhibit 22
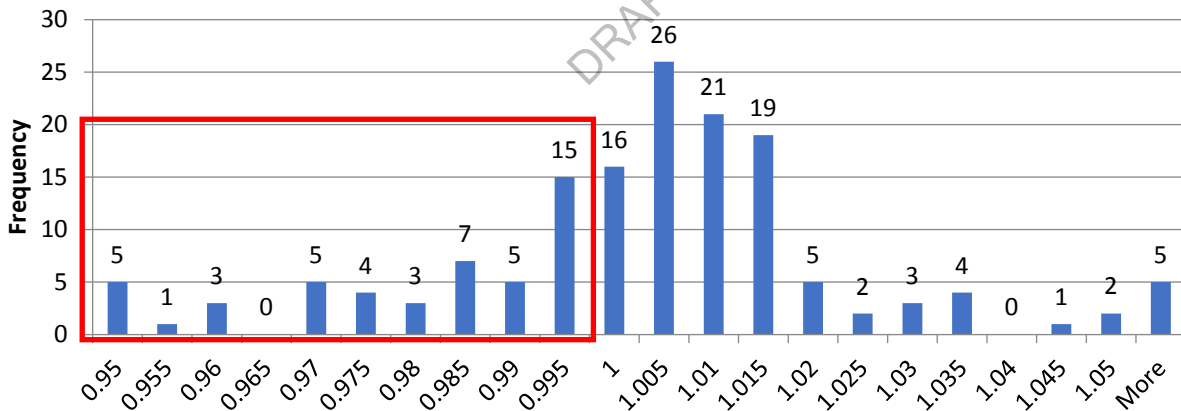
Comparison of 2019 YTD Gross Returns for TRI-SIGNAL Predictive SP500 vs SP500 ending Aug. 12
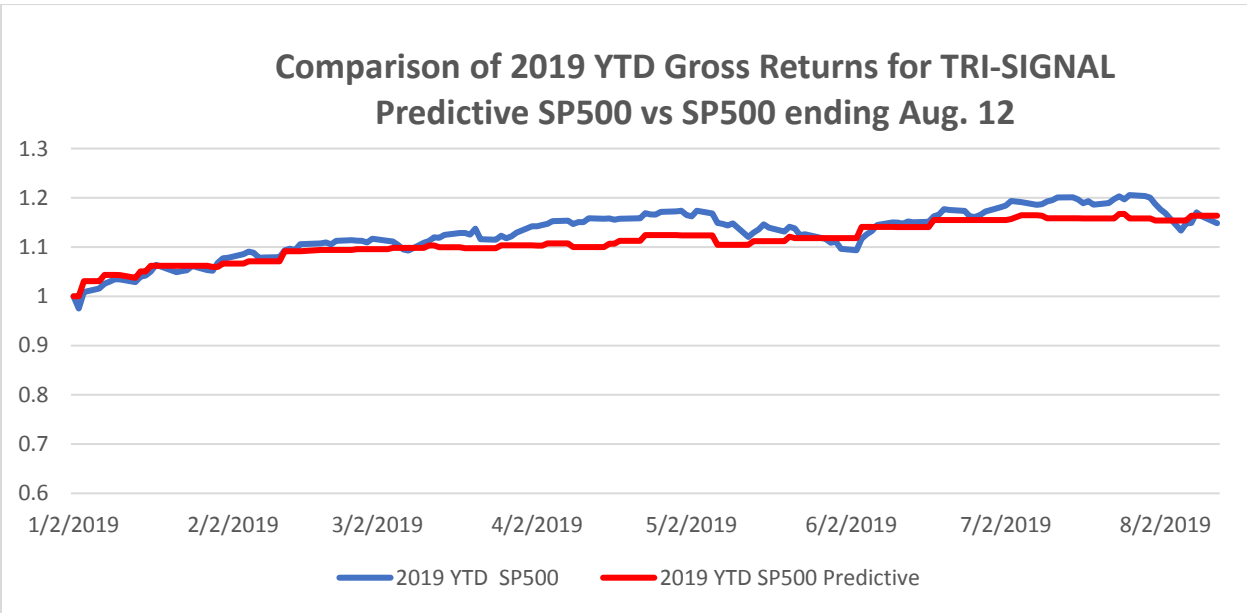
Exhibit 23

2019 was a bull market. 2019 SP500 YTD Predictive equity return thru Aug. 12 was 16.3% vs SP500 Daily Return of 14.8%. (See Exhibit 23.) Predictive equity filters out stocks by design and when stocks are collectively rising, the SP500 index will temporarily outperform predictive equity analytic returns as seen in Exhibit 23. Over longer durations, predictive equity is expected to outperform the index via filtering out of negative trending stocks. The predictive equity trend distribution is mean-variance dominant (mean = 1.004, stddev= 0.008) over the daily return distribution (mean = 1.001, stddev= 0.008). (See Exhibits 24 and 25.)

2019 SP500 Predictive Trend ending Aug. 12, 40 Trade days, YTD= 16.3%, Mean: 1.004, Stddev: 0.008, Sharpe: 118.4, Skew: 0.67, Kurtosis: 2.0

Left-tail filtering.

Exhibit 24

2019 SP500 Daily Trend ending Aug. 12, 155 Trading days, YTD= 14.8%, Mean: 1.001, Stddev: 0.008, Sharpe: 122.3, Skew: -0.25, Kurtosis: 3.1
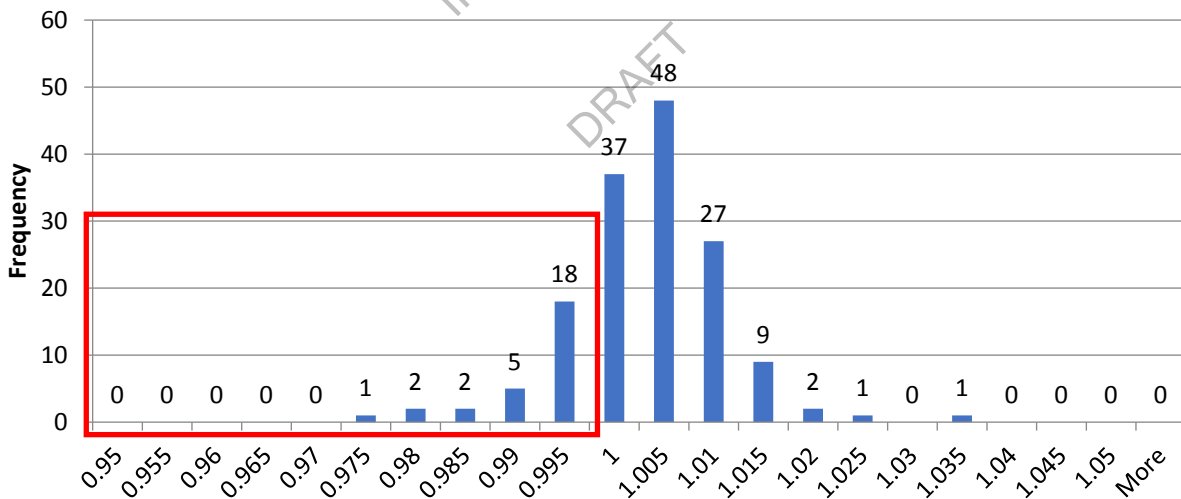

Exhibit 25

Appendix: TRI-SIGNAL Modeling Diagnostics

TRI-SIGNAL modeling performance is reported by 5 independent diagnostics using graphs in conjunction with raw accuracy measures:

1. **Bounding of stochastic realized daily trend process by next trade-day predicted (max, min) trend.**
2. **Linear regression:** concurrence of predictive power, correlation > 0.80
3. **Time series:** plot of realized daily trend versus proxy long run mean track nicely.
4. **Mean-variance:** two-dimensional movement in expected return vs standard deviation vs realized return demonstrates concurrence or coming correction.
5. **Distributional Evidence:** distribution of proxy of long run mean is "similar" to distribution of realized daily trend.

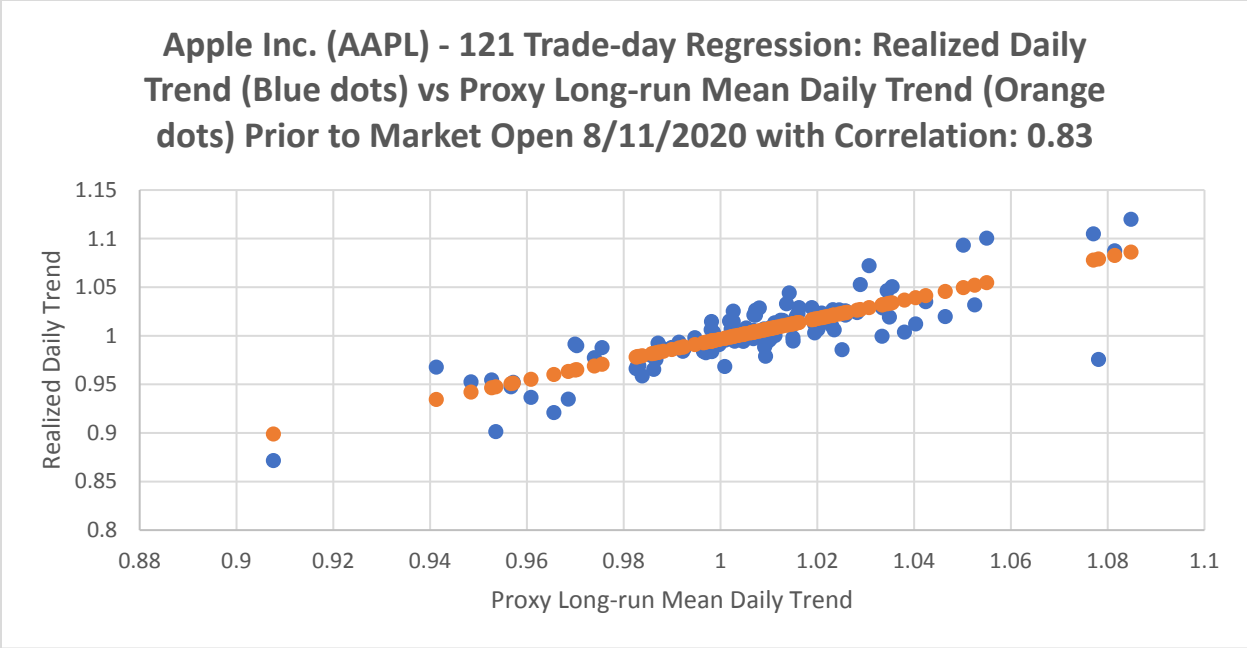See Exhibits 26 - 31 below.

Exhibit 26

Apple Inc. (AAPL) - 121 Trade-day Regression: Realized Daily Trend (Blue dots) vs Proxy Long-run Mean Daily Trend (Orange dots) Prior to Market Open 8/11/2020 with Correlation: 0.83

Exhibit 27

Apple Inc. (AAPL) - 121 Trade-day Time Series: Realized Daily Trend vs Proxy True Mean Trend Prior to Market Open 8/11/2020
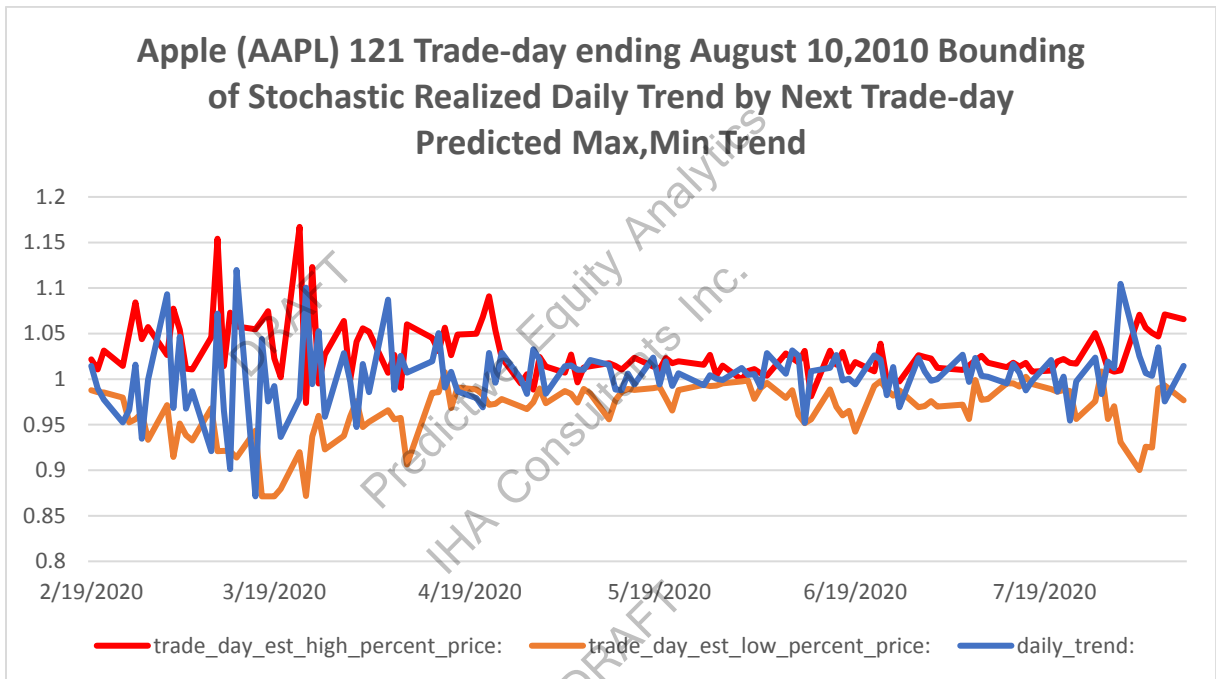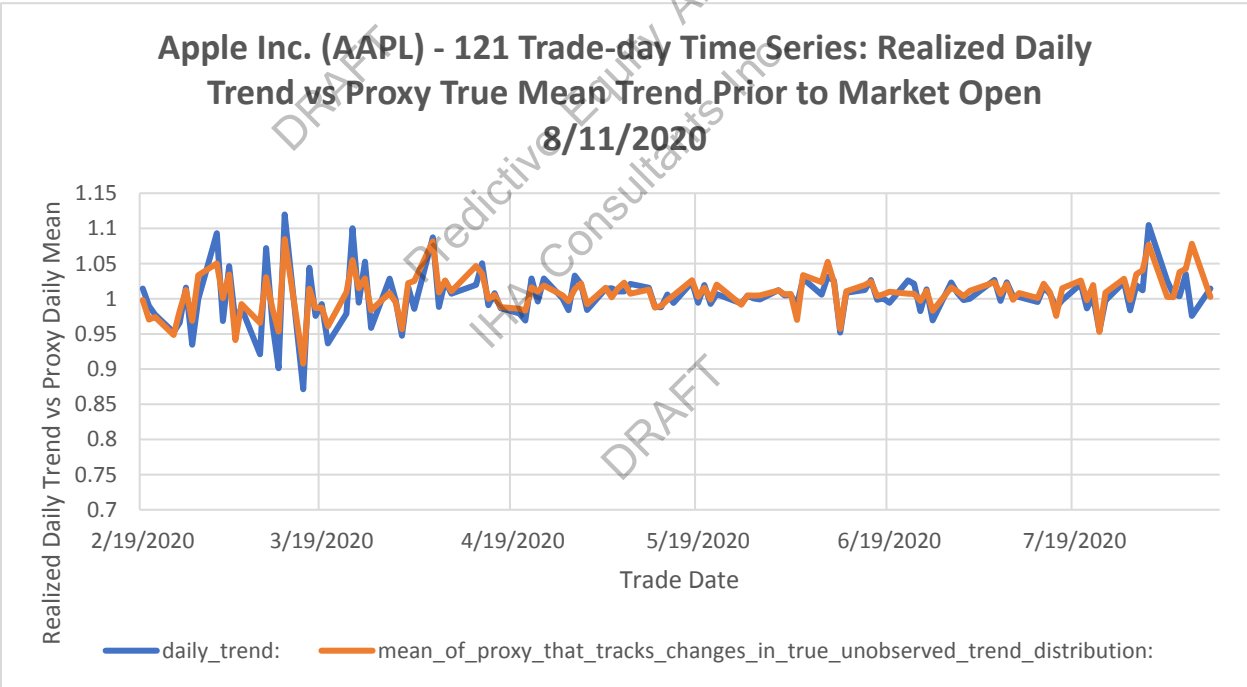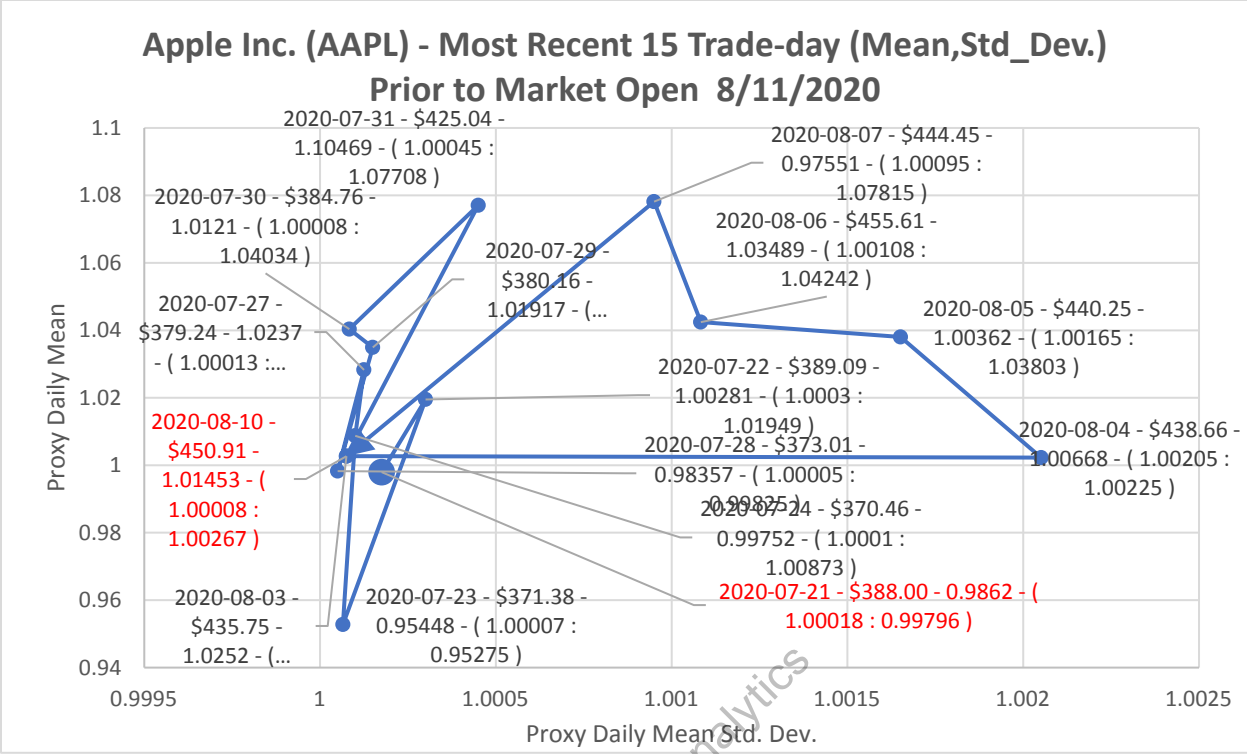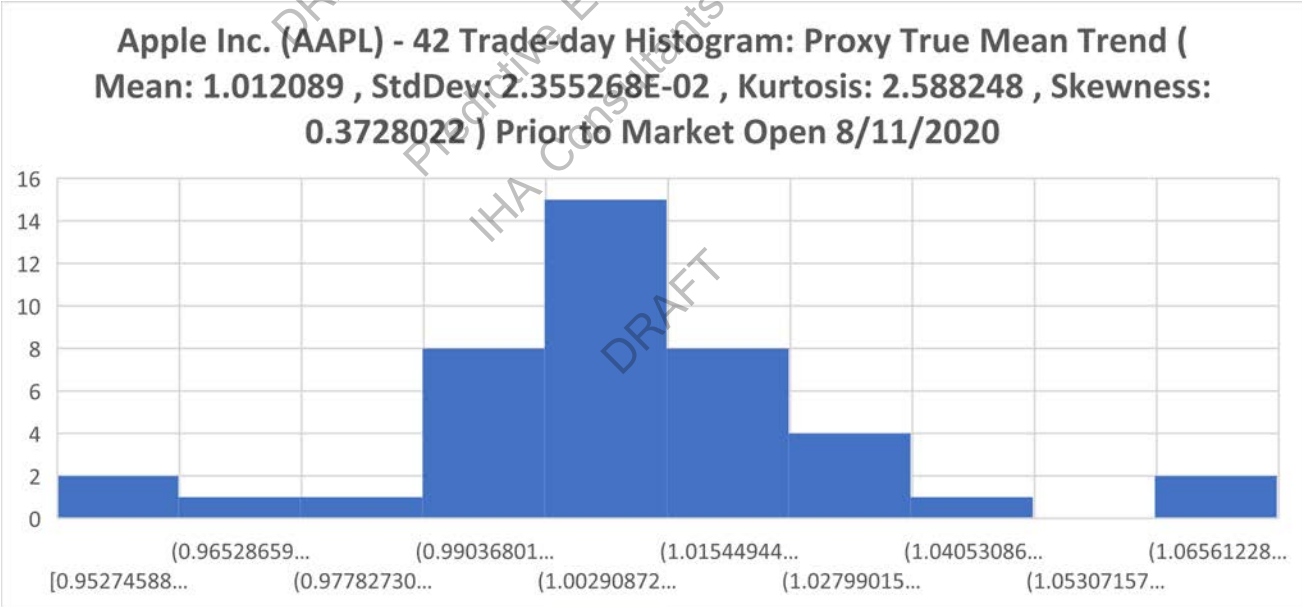
Exhibit 28

Exhibit 29

Exhibit 30

Apple Inc. (AAPL) - 42 Trade-day Histogram: Realized Daily Trend (Mean: 1.006141 , StdDev: 2.439179E-02 , Kurtosis: 5.974565 , Skewness: 1.092073) Prior to Market Open 8/11/2020
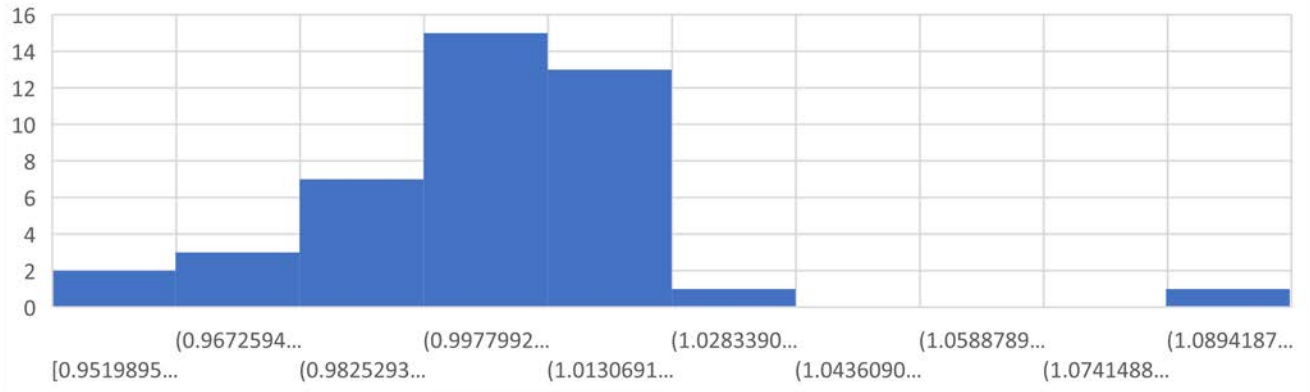
Exhibit 31