Hull
TACTICAL

## Today's Target Position: 105%   2018-12-13

Strategy Summary

The strategy is an ensemble of quantitative models with forecasting horizons between one day and six months. The strategy forecasts the excess returns of the S&P 500 index by utilizing a wide variety of proprietary analytical techniques. The Fund's investment approach is rooted in identifying and combining an array of signals spanning statistical, behavioral/sentiment, technical, fundamental, event based and economic data sources. Through the use of statistical techniques ranging from OLS, and kNN all the way to sophisticated machine learning methods, the portfolio managers continually investigate and evaluate the evolving complex relationships between these factors and the market.

When the strategy was launched in June 2015, stock market exposure was determined based on the output of a single six-month equity risk premium (ERP) model described in our paper "A Practitioner's Defense of Return Predictability"(2015). Since November 2015 we have introduced seven shorter term models. The monthly model, described in our paper "Return Predictability and Market-Timing: A One-Month Model"(2017) was added in July 2016. The other short term models have forecasting horizons of less than one month. We will expand this report to include more information on these other short term models as we publish more of our research.

Strategy exposure to the U.S. stock market can range from short 100% to long 200%. Volatility scaling was introduced in June 2017 to target 80% of the long-term volatility of S&P500.

Signal Decomposition
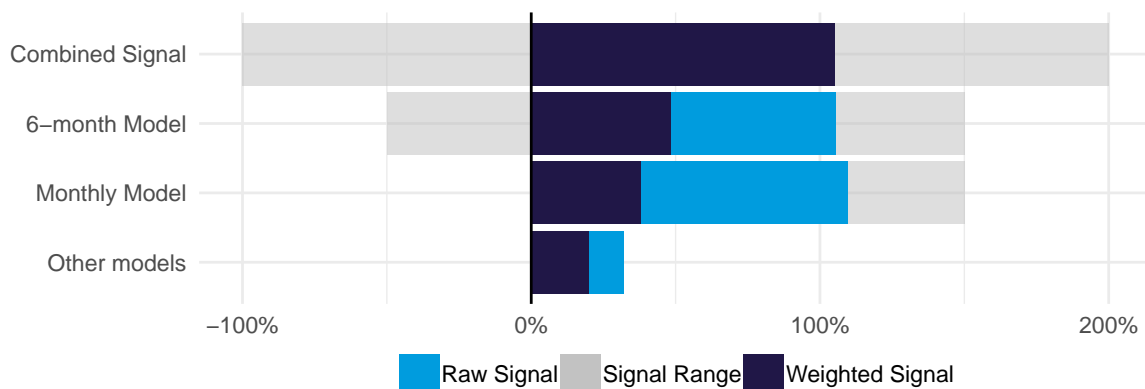
	Raw Signal	Weight	Weighted Signal
6-month Model	105%	46%	48%
Monthly Model	110%	35%	38%
Other models	32%	62%	20%
Combined Signal			105%

Model Description

The 6-month model employs OLS with correlation screening to find the most significant predictors from a group of 10 macroecomic and fundamental variables. The current estimate uses 5 of the 10 variables. The regression finds the historical sensitivity (the regression coefficient) of the next six months' excess return on the stock market to each variable. Each variable's forecast contribution is the product of its coefficient and value. Forecast contributions are capped, so no extreme value in a single variable can dominate all other variables. The forecast is the sum of the capped forecast contributions. The 6-month model uses a piecewise linear function to translate the ERP forecast into the target position in the S&P 500. The piecewise linear function targets a position of 100% if the ERP forecast equals the historical ERP. ERP forecasts above (below) the historical mean translate to target positions greater (less) than 100%. Target positions are constrained to lie between -50% and 150%. The piecewise linear function is shown below.

ERP forecast to target position
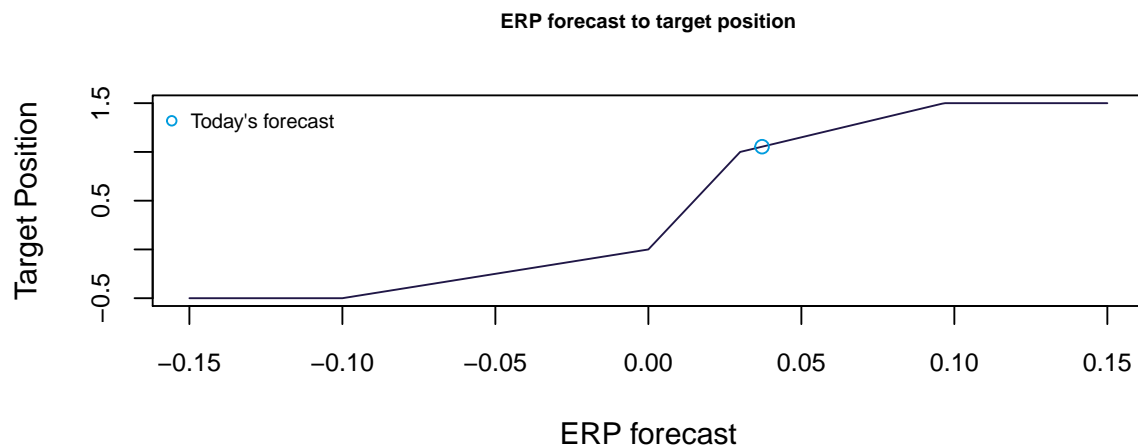
6-month Model Indicators

Next Refit in			13 days
Last Refit Date			2018-12-03

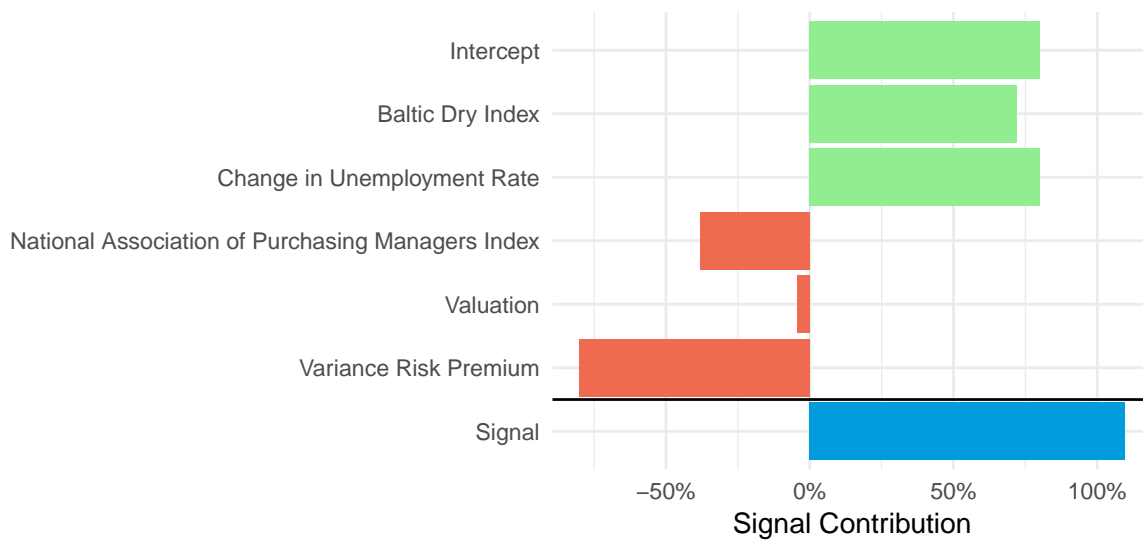|	Coefficient	Value	ERP forecast contribution
Intercept	4.59	1.00	4.59%
Baltic Dry Index	1.08	0.30	0.33%
FRB Loan Officer Survey	-7.56	-0.85	5.00%
Inflation	-5.15	0.44	-2.29%
New Orders / Shipments	-2.43	-0.03	0.06%
Valuation	-4.31	0.92	-3.98%
ERP forecast			**3.72%**
Allocation			**105%**

6-month Model Conclusions

Our unconditional forecast of the 6-month ERP is 4.59% (9.17% annualized). Valuation has a negative coefficient and is above its average. Therefore it contributes negatively to our ERP prediction and target position. New Orders / Shipments has a negative coefficient and is below its average. Therefore it contributes positively to our ERP prediction and target position. Inflation has a negative coefficient and is above its average. Therefore it contributes negatively to our ERP prediction and target position. FRB Loan Officer Survey has a negative coefficient and is below its average. Therefore it contributes positively to our ERP prediction and target position. Baltic Dry Index has a positive coefficient and is above its average. Therefore it contributes positively to our ERP prediction and target position. Given this, our 6-month ERP forecast is 3.72% (7.43% annualized) and we target a postion of 105% in the S&P 500.

Model Description

The monthly model employs stepwise weighted least squares to find the most significant predictors from a group of 16 diverse variables. The current estimate uses 5 of the 15 variables. The regression finds the historical sensitivity (the regression coefficient) of the next month's excess return on the stock market to each variable. Each variable's forecast contribution is the product of its coefficient and value. The forecast is the sum of the forecast contributions. The forecast is adjusted by dividing by the root mean squared error of the regression (RMSE). A larger RMSE is accompanied by a smaller bet size, as a result. The RMSE adjusted forecast is multiplied by five to scale the bets to a range between 0% and 150%. If a scaled bet falls below 0%, the actual bet is set to 0%. Likewise, if a scaled bet exceeds 150%, the actual bet is set to 150%.

Monthly Model Indicators

	Coefficient	Value	ERP forecast contribution	Signal contribution
Intercept	0.67	1.00	0.62%	80.00%
Baltic Dry Index	0.44	1.27	0.56%	71.99%
Change in Unemployment Rate	-1.18	-0.95	0.62%	80.00%
National Association of Purchasing Managers Index	0.32	-0.91	-0.30%	-38.02%
Valuation	-0.78	0.04	-0.03%	-4.41%
Variance Risk Premium	1.06	-1.39	-0.62%	-80.00%
Signal			**0.86%**	**109.56%**

Monthly Model Conclusions

Our unconditional forecast of the monthly ERP is 0.62% (7.49% annualized). Baltic Dry Index has a positive coefficient and is above its average. Therefore it contributes positively to our ERP prediction and

target position. Change in Unemployment Rate has a negative coefficient and is below its average. Therefore it contributes positively to our ERP prediction and target position. National Association of Purchasing Managers Index has a positive coefficient and is below its average. Therefore it contributes negatively to our ERP prediction and target position. Valuation has a negative coefficient and is above its average. Therefore it contributes negatively to our ERP prediction and target position. Variance Risk Premium has a positive coefficient and is below its average. Therefore it contributes negatively to our ERP prediction and target position. Given this, our monthly ERP forecast is 0.86% (10.26% annualized) and we therefore target a postion of 110% in the S&P 500.

The table below shows how we arrive at our daily allocation to the stock market based on input from models and individual variables within models. The values add up to the daily allocation percentage, so one can quickly see which models and variables are driving our stock market exposure. As we have said in earlier publications, stock market exposure can range from short 100% to long 200%. The daily allocations are scaled to target HTAA Strategy volatility equal to 80% of long term stock market volatility.

The HTAA ensemble of models has more than 40 individual inputs. Screening criteria can change the mix of inputs used to forecast stock market returns. So the list of inputs in the table below can change from time to time.

Variable[1]	Value
Baltic Dry Index	29%
Change in Unemployment Rate	28%
Federal Open Market Committee Meetings	0%
FRB Loan Officer Survey	65%
Inflation	-30%
Intercept	87%
National Association of Purchasing Managers Index	-13%
New Orders / Shipments	1%
Sell in May	9%
State Dependent Momentum	6%
Distributional Probability Model	0%
Intraday Mean Reversion	5%
Turn of the Month	0%
Valuation	-53%
Variance Risk Premium	-28%
Total	106%

[1]Items in italics represent short term models.

GLOSSARY

- **Baltic Dry Index (BDI)** – An assessment of the price of moving raw materials by sea, published daily in London by the Baltic Exchange.

- **Change in Unemployemnt Rate (UR)** – Monthly change in the unemployment rate.

- **Commodity Price (CP)** – The monthly change in the S&P GSCI index intended to track the movements in oil price. Fluctuations in the GSCI are predominantly driven by oil price changes.

- **Consumption versus Wealth and Income (CAY)** – Deviations from the equilibrium relationship among these three variables can predict future stock returns, according to a 2001 paper by Lettau and Ludvigson.

- **Credit Risk Premium (CRP)** – The difference between the BAA and AAA corporate bond yields, also known as the default spread.

- **Default Spread** – The difference between the low quality and high quality corporate bond yields, also known as the credit risk premium.

- **Delinquencies (DL)** – Annual change in loan delinquencies. Similar to FRB Loan Officer Survey, this is another variable that we use to capture the macroeconomic conditions of banks, and complements the information contained in FRB Loan Officer Survey.

- **Distributional Probability Model** - Binary investment strategy based on the probability of a positive return derived from the time varying return distribution.

- **Equity Risk Premium (ERP)** – The excess return that investing in the stock market provides over the return on a riskfree asset like U.S. Treasury bills. To report an annual forecast of the ERP, the 6 month forecast is taken and the historical mean ERP is added for the remaining 6 months.

- **Exchange Rate (EVUSD)** – Monthly change in the U.S. Dollar Index (DXY).

- **FRB Loan Officer Survey (LOAN)** – The Federal Reserve Bank Senior Loan Officer Opinion Survey on Bank Lending Practices is published quarterly. The survey reflects FRB correspondence with up to eighty large domestic banks and 24 U.S. branches and agencies of foreign banks. The survey provides information about bank credit standards (i.e., whether bankers are tightening or loosening lending standards).

- **Housing Starts (HS)** – Monthly difference in the housing starts index.

- **Implied Correlation** – Average pairwise correlation inferred from the relationship between the implied volatility of an index of stocks and the individual implied volatilities of the stocks that make up the index.

- **Implied Volatility** – An estimate of the future volatility of a stock based on prices of options on the stock.

- **Industrial Production (IP)** – Monthly percent change in the industrial production index.

- **Intercept** - Intercept term from the regression model.

- **k-nearest Neighbors Algorithm (kNN)** - Regression and classification technique based on finding the closest observations as defined by the chosen distance metric to make predictions.

- **National Association of Purchasing Managers (NAPM)** – The difference between the manufacturing survey new orders and the prices paid indices.

- **New Orders / Shipments(NOS)** – New orders for and shipments of manufactured durable goods, as published by the U.S. Department of Commerce.

- **Ordinary Least Squares (OLS)** - Method for estimating the unknown parameters in a linear regression model.

- **PCA** – Abbreviation for Principal Components Analysis. A statistical process that takes a large number of variables and produces a smaller number of variables that contain much or most of the information in the original large set of variables.

- **PCA of Price Indicators (PCA Price)** - The first principal component of the cyclically adjusted price-to-earnings ratio (CAPE), cyclically adjusted total yield (dividends plus buybacks), and the price-to-book ratio.

- **Refit** – The process of estimating the relationship between model indicators and future stock returns with the benefit of new data.

- **RMSE** - The root-mean-square error. It is a common measure of the differences observed values and values predicted by a model. High values of RMSE indicate that we are less confident about our model.

- **Sell in May (SiM)** – Also known as the Halloween effect, Sell in May is an investment strategy because on observation that the stock market has significantly higher returns in the period between November and April.

- **Short Interest** – A measure of aggregate stock market short interest based on a weighted sum of short interest of individual stocks. A market participant sells a stock short by borrowing it from a broker and selling it, hoping to buy it back at a lower price.

- **Slope of the Interest Rate Term Structure (STS)** – The difference between the 10-year Treasury note and the three-month Treasury bill yields from Bloomberg. This quantity is sometimes called the term spread.

- **State Dependent Momentum (SDM)** – It is an extension of a simple momentum strategy. It alows for different effects of momentum to be present in bullish and bearish states of the market.

- **Turn of the Month (ToM)** – It is an investment strategy based on a theory that stock prices increase in the last few and the first few trading days of each month.

- **Variance Risk Premium** – The difference between volatility estimates observed in markets and recent realized volatility.

Hull
TACTICAL