Trading The Russell 2000 5min Bars
Using The Adaptive Goertzel DFT System
Walk Forward 5 days in-sample and 1 day out-of-sample
Working Paper January 2016 Copyright © 2016 Dennis Meyers

In a previous working paper entitled "MESA vs Goertzel DFT",
http://www.meyersanalytics.com/publications2/MesaVsGDFT.pdf we demonstrated that the Goertzel Algorithm, a
subset of the Discrete Fourier Transform (DFT), has better frequency detection abilities of sine waves imbedded in
noise than the MESA algorithm when the noise amplitude is equal to or greater than the signal amplitude. MESA,
which stands for Maximum Entropy Spectral Analysis, is more commonly referred to as the Burg AR algorithm in
engineering and is a widely used mathematical technique designed to find the frequencies in data. MESA was
developed by J.P Burg for his Ph.D dissertation at Stanford University in 1975. The use of the MESA technique for
stocks and futures has been written about in many articles.

Previous researchers using MESA constrained themselves to using MESA to find only the cycle with the highest
amplitude and called that cycle the dominant cycle. In this paper we will find and use the frequencies with the three,
five or ten highest amplitudes to create a noise filtered signal curve that we will follow to create our strategy buy and
sell signals.

The Goertzel Algorithm.
The value of the Discrete Fourier Transform is that for N input data points, the DFT can not only find the
frequencies in the data but also the amplitude and phases of the sine waves in the data at the discrete frequency
points of 1/N, 2/N,…. to (N/2)/N. For instance if N, the number of price bars or closes, were equal to 20 we could
find the amplitude and phases for the 20 period cycle (20 bars/ cycle), the 10 period cycle, the 6 2/3 period cycle all
the way down to the 2 period cycle. We could then find the ten cycles with the highest amplitudes and reconstruct a
new signal with those ten periods, amplitudes and phases. Remember, cycle= 1/period. As traders we are more
accustomed to thinking of terms of periods like the 3 day cycle (frequency = 1/3 cycle/day) or the 10 bar cycle
(frequency = 1/10 cycles/bar) etc. Unfortunately the DFT can only calculate equally spaced frequencies of 1/N. In
the above example, where N=20, using the DFT we could only calculate the amplitudes of the periods
(periods=1/frequency) of 20, 10, 6 2/3 etc. What if the true signal period was between 20 and 10? The DFT
couldn't find it. That was the advantage of MESA. MESA was not constrained to the 1/N spacing. With MESA any
grid of frequencies could be examined. Fortunately, as shown in my previous article, a special subset of the discrete
Fourier transform called the Goertzel algorithm can be used to find frequencies in between the 1/N frequency
divisions. The Goertzel algorithm is used extensively in telephone tone detection. We all are familiar with cellular
phones. When you press a button have you ever wondered how the telephone company knows what button you
pushed? The answer is the Goertzel algorithm. This algorithm is built into tiny integrated circuits and immediately
(within milliseconds) detects the tone of the button you pushed. Here we will use the Goertzel algorithm to detect
the frequencies of the price series we give it.

Despite the advantage of the Goertzel algorithm frequency detection abilities, it has three drawbacks. One drawback
of the Goertzel algorithm is that it is much slower than the Fast Fourier transform. If we had 512 data points and we
wanted to look at 128 different frequencies, the FFT computation would be proportional to $512*\log_2(512)= 4608$
operations while the Goertzel computation would be proportional $512*128 = 65536$ operations. In other words, in
this case, the Goertzel algorithm would take more than 10 times longer than the FFT to compute. However, as a
computation time comparison, Goertzel would take about half the time as MESA to compute those 128 frequencies.
The second drawback of the Goertzel algorithm is that in order to find a frequency in Goertzel when the noise
amplitude is high you need enough data so that your lowest frequency (largest period) is able to complete at least 3
cycles. This means that if we were examining daily closing prices and we wanted to find periods of 75 days and less
than we would need at least 3*75=225 days of prices in order to detect that period in noisy data. The third drawback
of the Goertzel algorithm is that while it can detect the frequency within the 1/N spacing it cannot detect more than
one frequency within that spacing. For instance if N=20, and we are looking for a frequency between 1/20 and 2/20,
the Goertzel can detect the frequency anywhere at or between these two frequencies. However, if there were a
second frequency in-between these two frequencies, Goertzel could not find it. If there were two frequencies

between these two values, Goertzel would produce one frequency as a weighted average of the two. This is where MESA has a clear advantage. On data with a low noise component, Mesa could detect these two closely spaced frequencies. However, if the data is very noisy than MESA would not be able to detect the closely spaced frequencies either.

The Adaptive n Cycle Goertzel-DFT System.
The nature of intraday price movements is constantly changing due to current economic surprises, events and trader sentiment. Also the time of year changes the nature of intraday markets, such as the seasons, holidays, vacation time, etc. As such, the periods or frequencies found on intraday prices 3 weeks ago may no longer be the same as the frequencies found on today's intraday data. We would expect the frequencies found on intraday data to vary over time.

For this system we will create an indicator that walks forward one price bar at a time. The indicator will take a fixed number, N, of closing prices and use the Goertzel Algorithm (GZ) to find the M frequencies with the highest amplitudes. Using those frequencies' amplitudes and phases, we will construct a new price that forecasts the price one bar ahead. We will save this next bar forecast value, or forecast point. Next we will move the N closing prices forward one bar adding the next bar and dropping the last bar so that we have exactly N closing prices again. With this new N closing prices window we compute the next bar forecast value and save it. We keep marching the N closing price window forward one bar at a time, calculate and save the new forecast point until we reach the end of our data. We will then connect all the generated forecast points to produce a curve that creates the next bar forecast as the m frequencies used to create the next bar forecast change over time. Thus this curve adapts to the closing prices changing frequencies and projects one day ahead so that its lag is minimized when things change.

Adaptive Goertzel DFT System Construction Details
Unfortunately constructing the *n* cycle DFT of a price data series is not quite as simple as just taking N closing prices, and directly plugging them into a Goertzel algorithm.

The DFT assumes the time domain sample is periodic and repeats. Suppose a price series starts at 400 and wiggles and wags for 512 data samples ending at the value of 600. The DFT assumes that the price series starts at zero, suddenly jumps to 400, goes to 600 and suddenly jumps down to zero again and then repeats. The DFT must create all kinds of different frequencies in the frequency domain to try and match this type of behavior. These false frequencies created to match the jumps and the high average price completely swamp the amplitudes of any real frequencies making them look like noise. Fortunately this effect can be almost eliminated by a simple technique called end point flattening.

The calculation of end point flattening coefficients is simple. If $x(1)$ represents the first price in the sampled data series, $x(n)$ represent the last point in the data series and $y(i)$ equal to the new endpoint flattened series then:

$$a = x(1) \quad b=(x(n)-x(1))/(n-1)$$

$$y(i) = x(i) - [a+ b*(i-1)] \quad \text{for i=1 to n} \quad (1)$$

We can see that when i=1 then y(1)=0 and when i=n then y(n) =0. What we've done is subtract the beginning value of the time series to make the first value equal to zero and then rotate the rest of the time series such that the end point is now zero. This technique reduces the endpoint distortion but introduces a low frequency artifact into the Fourier Frequency spectrum. Fortunately we won't be looking for frequencies in that range so this distortion will have minimal impact.

n Cycle Goertzel-DFT Curve Construction
Before we start, we have to determine the largest period we will be looking to include in the *n* cycle Goertzel DFT construction. For intraday data the 3-day and 1 day cycles are very important. In this paper we will use 5-minute bars of the Russell 2000 Index Futures(TF). The TF trades on the Intercontinental Exchange (ICE) 22 hours a day. For our study we will only look at the US day trading session from 8:30am to 3:15pm CST Monday through Friday. Each day consists of 81 5min bars a day. Thus the 1-day cycle would need 81 bars. In order to detect the 1-

day cycle we need the cycle to repeat at least three times. This means we need at least 3*81= 243 data points in order to detect the 1-day cycle using 5-minute bars. The 3-day cycle would need 3*81=243 bars. In order to detect the 3-day cycle using the Goertzel algorithm we need at least 3*243=729 5min bars. There is a small trick we can use to reduce the number of bars to calculate the 3 day cycle. If we had 15min bars then there would be 27 15min bars per day and three days of 15min bars would be 3*27=81 15min bars. For the GZ we would need to calculate the 3day cycle of 15min bars we would need 3*81=243 15min bars of prices. Now suppose for the TF 5min bar data we took every third bar back in time instead of every bar. That would be exactly the same as taking the close of 15min bars. We would still need 729 5min bars but we would only be using 243 of them. For the next GZ computation we would advance one 5min bar and only use every third bar in the past as before. This why it would be like computing the GZ for 3 days of 15min bars but on every 5min bar moving forward. We will use 256*3=768 five min bars with every third bar equal to 256 15min bars of TF data which will detect both the 3-day all cycles below 3 days.

We will use the Goertzel algorithm described in our previous article to determine the top *n* frequencies with the highest amplitudes. "*n*", the number of frequencies with the highest amplitudes will be one of our optimization parameters. We will also use the Goertzel algorithm to determine the phases of the frequencies with the n highest amplitudes.

Step 1 End flatten the 256 15min bars (every third bar of 5min prices) prices using equation (1) above.

Step 2 Use the Goertzel algorithm to calculate the amplitudes for the frequencies of 1/81(3 day 15min bar period) down to 1/4. Frequency = 1/period. We are scanning for periods because as traders we think in terms of periods not frequencies. That is, the 1 day cycle, the 20 bar cycle etc. Thus, here we are scanning for frequencies of 81 bars/cycle to 4 bars/cycle. The frequencies of 3 bars/cycle down to 2 bars/cycle move to fast with 15min bars to take advantage trading these cycles. The slippage and commissions would eat up any profits made.

Step 3 Find the *n* frequencies with the highest amplitudes, calculate the phases of these frequencies and save these amplitudes (a[i]), phases (phi[i]) and frequencies (f[i]). Where [i] is one of the *n* highest amplitudes found.

Step 4 Calculate the forecast next bar value and the end point bar value using the above *n* frequencies, amplitudes and phases. The next bar forecast(fp) = $\sum$a[i]*cos(2*PI*f[i]*(257 15min bars) +phi[i]) i=1 to *n* and the Endpoint(ep) = $\sum$a[i]*cos(2*PI*f[i]*256(15min bars) +phi[i]) i=1 to *n* where a[i]=amplitude, f[i]=frequency , phi[i]=phase and *n* =number of frequencies used.

Step 5 Save the calculated forecast next bar point and the end point values. Call the forecast next point **fp(k)** and the end point **ep(k)** where k denotes the order of the sliding window. That is, the first sliding window k=1, the second, k=2, etc. Slide the 256 15min bars bar data window forward one 5min bar choosing every 3rd bar back, and repeat steps 1 through 4.

Why do we need **fp** and **ep**? When the data window is moved forward one bar at a time a new data sample is added to the end and the data sample at the beginning is subtracted. This adding and subtracting causes the end point flattening coefficients and the power in the frequency spectrum to jump around creating distortion and jitter in the calculation of the forecast next bar point. This random jumping as the data window slides forward in time adds a small random jump to the forecast next bar point curve. Fortunately this jumping can be minimized by creating a curve from the two saved end points, **fp(k)** and **ep(k)**, above in step 5. Since turning points are of interest rather than magnitude then in **step 5** a new variable will be created called **sumv** where

sumv(k) = sumv(k-1) + fp(k)-ep(k)

fp(k)-ep(k) is like a one bar ahead momentum or velocity. This new curve **sumv(k)** is the sum of all the changes in the next bar's *n* cycle forecast value fp(k) from the end point n cycle value. This change series minimizes the magnitude jump problem creating a fairly smooth momentum sum curve.

The Adaptive *n* Cycle Goertzel-DFT System Defined

Even though **sumv** is a fairly smooth curve it still has a number of short term wiggles preventing us from simply going long when the curve turns up and going short when the curve turns down. To create a system, we will use a simple curve following technique on TF 5-minute bars.

Buy Rule:
- **IF sumv** has moved up by more than the point amount of *pntup* from the lowest low recorded in **sumv** while short then buy the **TF** futures at the market..

Sell Rule:
- **IF sumv** has moved down by more than the point amount *pntdn* from the highest high recorded in **sumv** while long then sell the **TF** futures at the market.

Intraday Bars Exit Rule:
Close the position at 1500 CST (no trades will be carried overnight).

Intraday Bars First Trade of Day Entry Rule:

Ignore all trade signals before **8:30**am CST . For the Buy and Sell rules above we have included a first trade of the day entry rule.

Testing The Adaptive N Cycle Goertzel-DFT (GZ) System Using Walk Forward Optimization
There will be three strategy parameters to determine:
1. *ncy*, Number of Cycles (for this study we will look at 1(dominant cycle), 3 and 5 cycles).
2. *pntup*, if **sumv** has moved up by more than the point amount of *pntup* from the lowest low recorded in **sumv** while short then issue a buy signal
3. *pntdn*, **if sumv** has moved down by more than the point amount *pntdn* from the highest high recorded in **sumv** while long then sell

As mentioned, to test this system we will use five minute bar prices of the mini Russell 2000 index futures contract traded on the Intercontinental Exchange (ICE) and known by the symbol TF for the 335 trading days from August 12, 2014 to December 18, 2015.

We will test the GZ strategy with the above TS 5 min bars on a **walk forward basis**, where the in-sample(IS) will be 5 trading weekdays and the out-of-sample(OOS) will be the next trading weekday following as will be described below.

What Is A Walk Forward Optimization with In-Sample Section and Out-Of-Sample Sections?
Whenever we do a TS optimization on a number of different strategy inputs, TS generates a report of performance metrics (total net profits, number of losing trades, etc) vs these different strategy inputs. If the report is sorted on say the total net profits(*tnp*) performance metric column then the highest *tnp* would correspond to a certain set of inputs. This is called a **in-sample section**. If we choose a set of strategy inputs from this report based upon some performance metric, we have no idea whether these strategy inputs will produce the same results on future price data or data they have not been tested on. Price data that is not in the in-sample section is defined as **out-of-sample data**. Since the performance metrics generated in the in-sample section are mostly due to "curve fitting" or "data mining" it is important to see how the strategy inputs chosen from the in-sample section perform on out-of-sample data.

What do we mean by **"curve fitting" or data mining?** As a simple example, suppose you were taking a subway to work. In the subway car you are in, suppose you counted the number of blond women in that car and suppose the percent of blond women vs all other women hair colors was 80%. Being that you can't observe what is in the other subway cars, you would assume that all the other subway cars and perhaps all women had the same percentage of blond hair. This observation was due to chance. That is an example of curve fitting. The same goes for combinatorial searches. You are observing results from a finite sample of data without knowing the data outside the sample you examined.

Walk forward analysis attempts to minimize the curve fitting of price noise by using the law of averages from the Central Limit Theorem on the out-of-sample performance. In walk forward analysis the data is broken up into many in-sample and out-of-sample sections. Usually for any strategy, one has some performance metric selection procedure, which we will call a *filter,* used to select the input parameters from the optimization run. For instance, a *filter* example might be all cases that have a profit factor (PF) greater than 1 and less than 3. For the number of cases left, we might select the cases that had the best percent profit. This procedure would leave you with one case in the in-sample section output and its associated strategy input parameters. Now suppose we ran our optimization on each of our many in-sample sections and applied our filter to each in-sample section output. We would then use the strategy input parameters found by the *filter* in each in-sample section on the out-of-sample section immediately following that in-sample section. The input parameters found in each in-sample section and applied to each out-of-sample section would produce independent net profits or losses for each of the out-of-sample sections. Using this method we now have "x" number of independent out-of-sample section profit and losses from our filter. If we take the average of these out-of-sample section net profits and losses, then we will have an estimate of how our strategy will perform on average. Due to the Central Limit Theorem, as your sample size increases, the spurious noise results in the out-of-sample section performance tend to average out to zero in the limit, leaving us with what to expect from our strategy and filter. ***Mathematical note: This assumption assumes that the out-of-sample returns are from probability distributions that have a finite variance.***

Why use the walk forward technique? Why not just perform an optimization on the whole price series and choose the input parameters that give the best total net profits or profit factor? Surely the price noise cancels itself out with such a large number of in-sample prices and trades. Unfortunately, nothing could be farther from the truth! Optimization is a misnomer and should really be called combinatorial search. As stated above, whenever we run a combinatorial search over many different combinations of input parameters on noisy data on a fixed number of prices, ***no matter how many***, the best performance parameters found are guaranteed to be due to *"curve fitting"* the noise and signal. The price series that we trade consists of random spurious price movements, which we call noise, and repeatable price patterns (*if they exist*). When we run, for example, 5000 different inputs parameter combinations , the best performance parameters will be from those strategy input variables that are able to produce profits from the price pattern **and** the random spurious movements While the price patterns will repeat, the same spurious price movements will not. If the spurious price movements that were captured by a certain set of input parameters were a large part of the total net profits, as they are in real intraday price series, then choosing these input parameters will produce losses when traded on future data. These losses occur because the spurious price movements will not be repeated in the same way. This is why strategy optimization or combinatorial searches with no out-of-sample testing cause loses when traded in real time from something that looked great in the in-sample section.

In order to gain confidence that our input parameter selection method using the optimization output of the in-sample data will produce profits, we must test the input parameters we found in the in-sample section on out-of-sample data. In addition, we must perform the in-sample/out-of-sample analysis many times. Why not just do the out-of-sample analysis once or just 10 times? Well just as in Poker or any card game, where there is considerable variation in luck from hand to hand, walk forward out-of-sample analysis give considerable variation in day-to-day out-of-sample profit "luck". That is, by pure chance we may have chosen some input parameter set that did well in the in-sample section data **and** the out-of-sample section data. In order to minimize this type of "luck", statistically, we must repeat the walk forward out-of-sample (oos) analysis over many (>50) in-sample/out-of-sample sections and take an average over all out-of-sample sections. This average gives us an expected out-of-sample return and a standard deviation of out-of-sample returns which allows us to statistically estimate the expected equity and its range for N out-of-sample periods in the future

Finding The GZ Strategy Parameters Using Walk Forward Optimization
There are three strategy parameters to find *ncy, pntup and pntdn.*

For the test data we will run the TradeStation optimization engine on **TF** 5 min price bars(using every third bar) from 8/12/2014 to 12/18/2015 with the following optimization ranges for the GZ strategy inputs. This will create **335, 5 weekday in-sample periods each followed by a 1 day out-of-sample period** (See Figure 1 for the in-sample/out-of-sample periods). The days are weekdays only . Weekdays where the OOS falls on a exchange holiday or partial

days are eliminated. Holidays that fall on a weekday create a 4day IS. All other *IS* periods consist of 5 trading weekdays.

The optimization ranges are:
1. **ncy= 1,3,5**
2. **pntup from 0.25 to 6 steps of 0.25**
3. **pntdn from 0.25 to 6 in steps of 0.25**
4. trh = 0 not used
5. iepflat = 1
6. tstart=0.375
7. logofcls=0
8. nsamp = 256 number of bars for GZ computation
9. nX= 3 chooses every 3rd 5min bar
10. myStartTime = 830
11. Xopn = 0
12. Xtime = 1500
13. XonCls =0
14. xmult = 1
15. prc = c

The above ncy, pntup and pntdn ranges will produce 1728 different input combinations or cases of the strategy input parameters for each of the 335 in-sample/out-of-sample files for the 16 months of 5 min bar TF data.

The question we are attempting to answer statistically is which best performance metric or combination of best performance metrics (which we will call a *filter*) applied to the in-sample section will produce in-sample strategy inputs that produce statistically valid profits in the out-of-sample section. In other words we wish to find a performance metric *filter* that we can apply to the in-sample section that can give us strategy inputs that will produce, on average, good trading results in the future.

When TS does an optimization routine over many combinations of inputs, it creates output page that has as its rows each strategy input combination and as it's columns various trading performance measures such as Profit Factor, Total Net Profits, etc. An example of a simple filter would be to choose the strategy input optimization row in the in-sample section that had the highest Net Profit or perhaps a row that had the best Profit Factor with their associated strategy inputs. Unfortunately it was found that this type of simple metric performance filter very rarely produces good out-of-sample results. More complicated metric filters can produce good out-of-sample results minimizing spurious price movement biases in the selection of strategy inputs.

Here is a combination *filter* that is used in this paper with good out-of-sample results. High profit factors (**PF**) in the in-sample section usually mean poor performance in the out-of-sample-section. This is a kind of reversion to the mean. So in the in-sample section we eliminate all strategy input rows that have a **PF>2.5** . In addition we wish to limit the number losing trades in a row in the 5 day IS period to 2 or less (**LR<2**). The PWFO generates the metric **mWTr.** This metric is the in-sample **mWTr= Median Of The Winning Trades.** This is the median of the winning trades. We take the median of the winning trades to minimize the effect of large winning trades that may be outliers that are not repeatable. Let us choose the 20 rows that contain the Largest(Top) **mWTr** values from the rows that are left from the **PF** -**LR** elimination. This particular filter will now leave 20 cases or rows in the in-sample section that satisfy the above filter conditions. . Suppose for this filter, within the 20 in-sample rows that are left, we want the row that has the maximum PWFO metric **mWb** in the in-sample section. **mWb=Median Of The Trade Winning Bars** Each winning trade takes a certain number of bars. If we order the number of bars each winning trade takes then the median of all the winning trade bars is a robust statistic. We take the median of the winning trades bars to minimize the effect of large and small winning trade bars that may be outliers and that can distort this statistic.. This would produce a filter named **t20mWtr|p<2.5|l2-mWb.** This in-sample filter leaves only one row in the PWFO in-sample section with its associated strategy inputs and out-of-sample net profit in the out-of-sample section. This particular **t20mWTr|p<2.5|l2-mWb** filter finds the strategy inputs parameters in each of the 335 in-sample sections and applies these inputs to the out-of-sample section. Using the filter in-sample strategy inputs on the 335 out-of-sample sections, the average out-of-sample performance is

calculated. In addition many other important out-of-sample performance statistics for this filter are calculated and summarized. **Figure 3** shows such a filter computer run along with a small sample of other filter combinations that are constructed in a similar manner. **Row 3** of the sample output in **Figure 3** shows the results of the filter discussed above. A total of 19220 different metric filters were examined. More on this below on how that number of filters combinations effect the probability that the filter chosen was or was not due to chance.

Bootstrap Probability of Filter Results.

Using modern "Bootstrap" techniques, we can calculate the probability of obtaining our filter's total out-of-sample *net* profits by chance. Here is how the bootstrap technique is applied. Suppose as an example, we have 100 files of in-sample/out-of-sample data. A mirror random filter is created. Instead of picking an out-of-sample net profit (OSNP) from a filter row as before, the mirror filter picks a *random* row's OSNP in each of the 100 files. We repeat this random picking in each of the 100 files 5000 times. Each of the 5000 mirror filters will choose a random row's OSNP of their own in each of the 100 files.. At the end, each of the 5000 mirror filters will have 100 *random* OSNP's picked from the rows of the 100 files. The sum of the 100 random OSNP picks for each mirror filter will generate a random total out-of-sample net profit (tOnpNet) or final random equity. The average and standard deviation of the 5000 mirror filter's different random tOnpNets will allow us to calculate the chance probability of our above chosen filter's tOnpNet. Thus given the mirror filter's bootstrap random tOnpNet average and standard deviation, we can calculate the probability of obtaining our chosen filter's tOnpNet by pure chance alone. Figure 3 lists the 5000 mirror filter's bootstrap average for our 335 out-of-sample files of (**$1747)** with a bootstrap standard deviation of **$1368**. The probability of obtaining our filters net profit of **$53,220** is **2.96x10^{-5}** which is **4.02** standard deviations from the bootstrap average. For our filter, in row 3 in Figure 3, the expected number of cases that we could obtain by pure chance that would match or exceed the **$53220** is **19220**x **2.96 10^{-5} = 0.57** where **19220** is the total number of different filters we looked at in this run. This number is less than one so it is improbable that our result was due to pure chance.

Results

Figure 1 presents a graph of the equity curve generated by using the filter on the 335 days ending 8/19/14 to 12/18/15 (note the starting date 8/1/14 was part of the first 5 day in-sample period plus the number of MaxBarsBack (256*3=758 5min bars ~10 trading days) and the OOS weekday after the 5 trade day in-sample was 8/19/14. The equity curves is plotted from Equity and Net Equity columns in Table 1. Plotted on the equity curves is the 2nd Order Polynomial curve. The blue line is the equity curve without commissions and the red dots on the blue line are new highs in equity. The brown line is the equity curve with commissions and the green dots are the new highs in net equity. The grey line is the TF Daily Closing prices superimposed on the Equity Chart.

Figure 2 presents a plot of the GZ Strategy buy/sells and the GZ Indicator on the TF 5min bars for 12/16-2015 - 12/18/20115.

Table 1 below presents a table of the 335 in-sample and out-of-sample windows, the **Filter** selected in-sample strategy inputs and the daily out-of-sample profit/loss results using the filter described above.

Discussion of Strategy Performance
In Figure 3, Row 3 of the spreadsheet filter output are some statistics that are of interest for our filter. An interesting statistic is **Blw**. Blw is the maximum number of days the OSNP equity curve failed to make a new high. Blw is 38 days for this filter. This means that 38 trading days was the longest time that the equity for this strategy failed to make a new equity high. %Wtr is the percentage of all OOS trades that were wins or positive. For this filter the %Wtr=56%, %P=% winning oos days =59% and the ave oos winning trade to the ave oos losing trade ratio(oW|oL) was 1.17

To see the effect of walk forward analysis, take a look at **Table 1**. Notice how the input parameters *ncy, pntup, pntdn* take sudden jumps from high to low and back . This is the walk forward process quickly adapting to changing volatility conditions in the in-sample sample.

In Figure 1, which presents a graph of the equity curve using the filter on the 335 trading days of out-of-sample data, notice how the equity curve follows the 2nd order polynomial trend line with an R^2 of 0.98. This R^2 only dropped to 0.97 for the net equity curve. In addition sharp drops of the Daily TF in the last week of August 2014 did not produce sharp drops in the equity. Further big drops of TF in the last week of September 2015 did not produce big drops in equity. In comparing the equity curve to TF price moves both up and down the GZ strategy handled both up and down moves of TF with relatively smooth and consistent up trending equity curve profits.

Using this filter, the strategy was able to generate $53,220 net equity after commissions and slippage of $20 trading one TF contract for 335 days.   This period of time from 8/12/14 to 12/18/15 was a volatile market. Yet the GZ strategy was able to adapt quite well.   From Figure 3 and Table 1, the largest losing OOS trade was -$3700 and the largest losing day was -$3170 on 10/8/14 .The largest drawdown was -$5610 from 11/6/15 to 11/19/15. This drawdown lasted 9 trading days and completely recovered and made a new equity high in 6 trading days. The longest time between new equity highs was 38 days.

In observing Table 1 we can see that this strategy and filter made trades from a low of 1 trade/day to a high of 4 trades/day with an average of 1.7 trades/day with a medium of 2 trades/day. For the no trade days, the inputs found by the filter in the in-sample section generated no trades in the out-of-sample section.

Given 23 hour trading of the TS, restricting the strategy to trade only from 830am to 3:00pm CT caused the strategy to miss many profitable trends opportunities when Asia and then Europe opened trading in the early morning. Further research will include the A.M. time zones.

Disclaimer
The strategies, methods and indicators presented here are given purely for educational purposes and to facilitate the research and study of trading methods in the financial markets. Hypothetical out-of-sample test results are no guarantee of future profits. Please be aware that the positive performance presented here is based upon hypothetical trading and can in no way give any assurances or claim that the strategy and methods presented here will produce profits in the future and in fact may create financial losses.

References:
1. Burg, J. P., 'Maximum Entropy Spectral Analysis", Ph.D. dissertation, Stanford University, Stanford, CA. May 1975.
2. Goertzel, G., "An Algorithm for the evaluation of finite trigonometric series" American Math Month, Vol 65, 1958 pp34-35.
3. Kay, Steven M., "Modern Spectral Estimation", Prentice Hall, 1988
4. Marple, Lawrence S. Jr., "Digital Spectral Analysis With Applications", Prentice Hall, 1987
5. Meyers, Dennis , "MESA vs Goertzel DFT", *Working Paper*, http://meyersanalytics.com/articles.htm
6. Press, William H., et al, "Numerical Receipts in C++: the Art of Scientific Computing", Cambridge Press, 2002.
7. Oppenheim, A, Schafer, R. and Buck, J., "Discrete Time Signal Processing", Prentice Hall, 1996, pp663-634
8. Proakis, J. and Manolakis, D. "Digital Signal Processing-Principles, Algorithms and Applications", Prentice Hall, 1996., pp480-481

**Figure 1   Graph of GZ Strategy Equity Applying the Walk Forward Filter Each Day on the in-sample section
On TF 5min Bar Prices 8/19/2014 to 12/18/2015**

Note: The blue line is the equity curve without commissions and the red dots on the blue line are new highs in equity.
The brown line is the equity curve with commissions and the green dots are the new highs in net equity
The grey line is the TF Daily Closing prices superimposed on the Equity Chart.

TF5GZ_5dx1d **t20mWTr|p<2.5|l2-mWb**   08/19/14 To 12/18/2015

$y = 0.1714x^2 + 132.4x + 463.98$
$R^2 = 0.982$

$y = 0.1703x^2 + 98.806x + 505.25$
$R^2 = 0.9731$
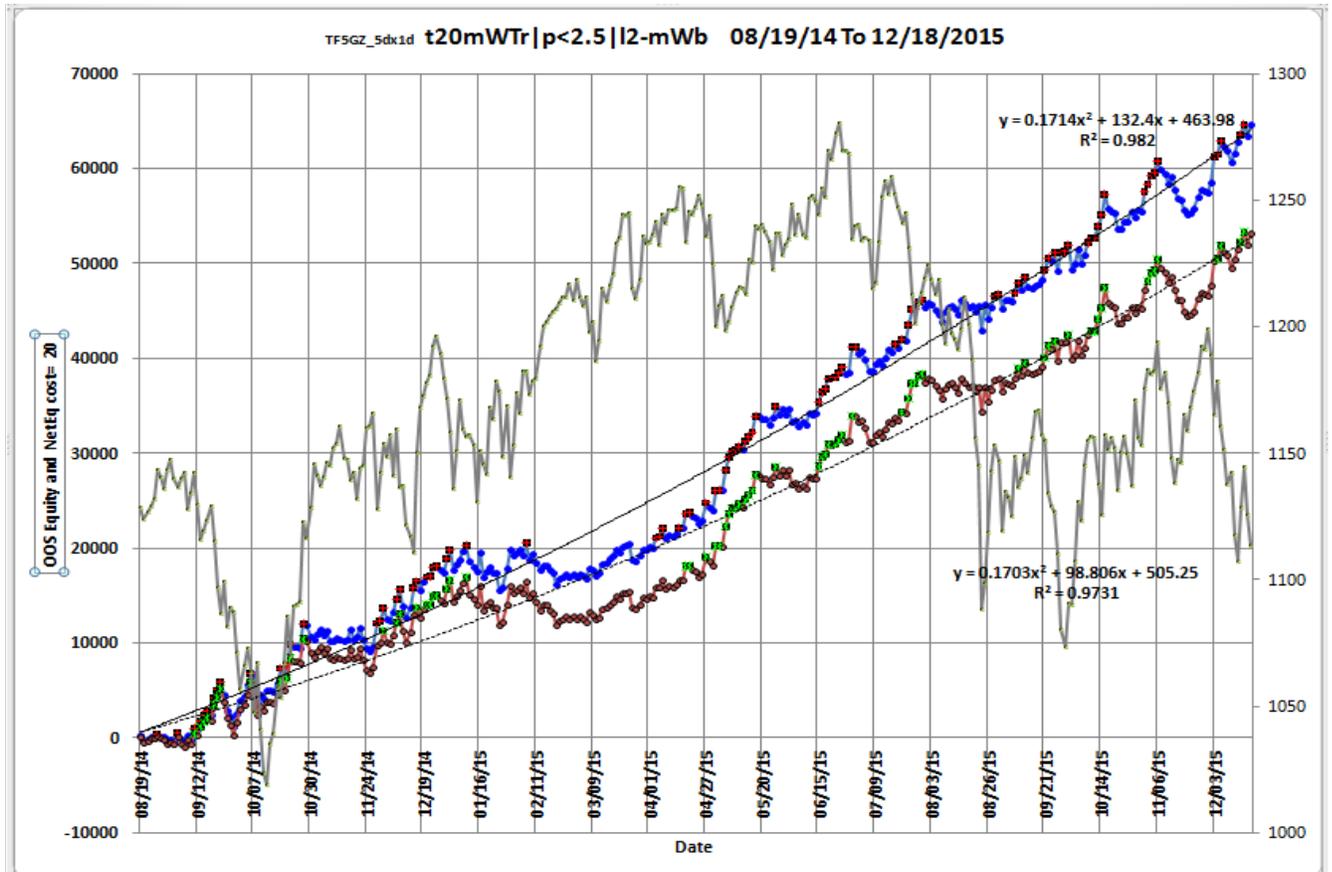
Figure 2   TF GZ System 5 minute bar chart from 12/15/15-12/18/15

Figure 3   Partial output of the Walk Forward Metric Performance Explorer (WFME)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	TF5GZ-5dx1d	s08/19/14	e12/18/15	#335	AnyTnp							a(1747)	s13686	f19220							c=$20				
2	Filter-Metric	toGP	aoGP	aoTr	ao#T	aoW	aoL	oW|oL	%Wtr	%P	t	std	LLtr	LLp	eqDD	pLR	#	eqTrn	eqV^2	eqR2	Dev^2	Blw	BE	tOnpNet	Prob
3	t20mWTr|p<2.5|l2-mWb	64600	193	113.5	1.7	612	523	1.17	56	59	3.76	939	-3700	-3170	-5610	5	335	190	247	98	2881	38	94.8	53220	2.96E-05
4	t20mWTr|p<2.5|l3-tWb	60920	182	101.4	1.8	613	485	1.26	53	58	3.71	898	-3550	-3620	-7480	5	334	167	72	94	4173	69	96.9	48900	1.08E-04
5	t20mWTr|p<2.5|l3-mWb	57490	173	104.1	1.7	619	541	1.14	56	57	3.37	937	-4130	-3170	-7520	6	332	165	178	95	3462	80	117.2	46450	2.15E-04
6	t20mWTr|p<2.5|l3-tWb|tLb	57930	174	98.5	1.8	612	498	1.23	54	59	3.56	892	-3550	-3620	-5360	5	332	144	103	94	3446	71	104.6	46170	2.32E-04
7	t20mWTr|p<2|l3-tWb|tLb	56790	171	95.0	1.8	615	484	1.27	53	57	3.43	907	-3550	-2720	-5920	6	333	130	67	88	4683	47	113.1	44830	3.33E-04
8	t20mWTr|p<2.5|l3-eq2b1	55310	166	97.7	1.7	642	487	1.32	52	57	3.42	886	-2190	-2800	-8460	7	334	170	98	97	3077	47	114.4	43990	4.16E-04
9	t20mWTr|p<2.5|l3-eq2b1	55370	166	97.1	1.7	622	495	1.26	53	57	3.38	896	-2680	-3170	-5660	7	334	178	159	98	2663	42	116.8	43970	4.18E-04

The WFME Filter Output Columns are defined as follows: OOS=out-of-sample

Row 1 TF5GZ-5dx1d is the PWFO output files abbreviation, First OOS Day End Date(8/19/14), Last OOS Day End Date(12/18/15), **Number of days**(#335) **a**=average of bootstrap random picks. **s**= standard deviation of bootstrap random picks. **f**=number of different filters examined. **c**= slippage and round trip trade cost(c=$20).

Filter = The filter that was run. Row 3 filter **t20mWTr|p<2.5|l2mWb**

t20mWTr|p<2.5|l2mWb filter produced the following average 335 day statistics on row 3.

toGP = Total out-of-sample(oos) Gross profit for these 335 days.

aoGP = Average 1 day oos gross profit for the 335 days

aoTr = Average oos profit per trade

ao#T = Average number of oos trades per day

aoW = Average of the oos winning trades

aoL = Average of the oos losing trades

oW|oL = aoW/aoL the ratio of the winning oos trades to losing oos trades.

%Wtr = The percentage of oos trades that were profitable

%P = The percentage of oos days that were profitable

t = The student t statistic for the 335 daily oos profits. The higher the t statistic the higher the probability that this result was not due to pure chance

std = The standard deviation of the 335 daily oos profits

LLtr = The largest losing oos trade in the whole period

LLp = The largest losing oos period(day)

eqDD = The oos equity drawdown

plr = The largest number of losing oos days in a row

= The number of days this filter produced a daily result. Note for some days there can be no strategy inputs that satisfy a given filter's criteria.

eqTrn = The straight line trend of the oos gross profit equity curve in $/day.

eqV^2 = The ending velocity of 2nd order polynomial that is fit to the equity curve

eqR2 = The correlation coefficient(r^2) of a straight line fit to the equity curve

Dev^2 = A measure of equity curve smoothness. The square root of the average [(equity curve minus a straight line)^2]

Blw = The maximum number of days the oos equity curve failed to make a new high.

BE = Break even days. Assuming the average and standard deviation are from a normal distribution, this is the number of days you would have to trade to have a 98% probability that your oos equity is above zero.

tOnpNet = Total out-of-sample net profit(tOnpNet) minus the total trade cost.
  tOnpNet=tOnp – (Number of trade days)*aOnT*Cost.

Prob = the probability that the filter's tOnpNet was due to pure chance.

Table 1   Walk Forward Out-Of-Sample Performance Summary for the TF 5-min Goertzel Strategy

TF-5 min bars 8/19/2014 - 12/18/2015. The input values *ncy, pntup, pntdn* are the values found from applying the filter to the in-sample section optimization runs.

Filter: t20mWTr|p<2.5|l2-mWb PF<=2.5, LR<=2 then top 20 mWTr, maximum mWb

osnp = Weekly Out-of-sample net profit from strategy inputs chosen by In-sample Section filter

ont = The number of trades in the out-of-sample week from strategy inputs chosen by In-sample Section filter.

NOnp$20 = osnp-ont*$20

ollt = out-of-sample largest losing trade for that week from strategy inputs chosen by In-sample Section filter.

odd = Out-of-Sample closing trade drawdown for that week

Equity = running sum of the weekly out-of-sample profits(Osnp)

NetEq = running sum of weekly out-of-sample profits minus $25*Ont

Note: Blank rows indicate that no out-of-sample trades were made that week

In-Sample Dates			OOS Date	osnp	ont	NOnp$20	ollt	odd	equity	NetEq	ncy	pntup	pntdn	TF Close
08/12/14	To	08/18/14	08/19/14	220	2	180	0	0	220	180	3	4.75	5.75	1128.8
08/13/14	To	08/19/14	08/20/14	-580	2	-620	-400	-580	-360	-440	1	0.75	0.25	1124.1
08/14/14	To	08/20/14	08/21/14	200	1	180	0	0	-160	-260	1	1.25	0.25	1126.8
08/15/14	To	08/21/14	08/22/14	210	1	190	0	0	50	-70	1	2	3.5	1129.2
08/18/14	To	08/22/14	08/25/14	10	1	-10	0	0	60	-80	1	1.25	0.25	1132.1
08/19/14	To	08/25/14	08/26/14	300	2	260	-310	-310	360	180	1	1.25	5	1143.6
08/20/14	To	08/26/14	08/27/14	-170	2	-210	-260	-260	190	-30	1	1.75	0.5	1140.8
08/21/14	To	08/27/14	08/28/14	-80	1	-100	-80	-80	110	-130	1	0.25	3	1136.2
08/22/14	To	08/28/14	08/29/14	-480	2	-520	-520	-520	-370	-650	3	3.25	4.75	1143.3
08/26/14	To	09/01/14	09/02/14	160	2	120	0	0	-210	-530	1	0.75	2.5	1147.5
08/27/14	To	09/02/14	09/03/14	-50	3	-110	-500	-500	-260	-640	1	0.5	3.75	1140
08/28/14	To	09/03/14	09/04/14	760	1	740	0	0	500	100	1	5	5.5	1136.5
08/29/14	To	09/04/14	09/05/14	-690	1	-710	-690	-690	-190	-610	1	5	4.25	1139.9
09/01/14	To	09/05/14	09/08/14	-270	1	-290	-270	-270	-460	-900	1	4.5	2.75	1142.5
09/02/14	To	09/08/14	09/09/14	810	1	790	0	0	350	-110	1	5	5.5	1128.3
09/03/14	To	09/09/14	09/10/14	-540	2	-580	-560	-560	-190	-690	3	3.75	1.25	1134.2
09/04/14	To	09/10/14	09/11/14	1190	1	1170	0	0	1000	480	1	0.25	5.25	1142.5
09/05/14	To	09/11/14	09/12/14	-160	3	-220	-570	-570	840	260	5	3	6	1129.7
09/08/14	To	09/12/14	09/15/14	940	1	920	0	0	1780	1180	1	6	0.25	1116.1
09/09/14	To	09/15/14	09/16/14	540	1	520	0	0	2320	1700	1	1.5	4.5	1119.6
09/10/14	To	09/16/14	09/17/14	480	2	440	0	0	2800	2140	1	6	0.25	1123.4
09/11/14	To	09/17/14	09/18/14	-310	1	-330	-310	-310	2490	1810	1	1.5	1	1129.3
09/12/14	To	09/18/14	09/19/14	1670	1	1650	0	0	4160	3460	1	6	1.75	1115.3
09/15/14	To	09/19/14	09/22/14	860	1	840	0	0	5020	4300	1	6	2	1097.2
09/16/14	To	09/22/14	09/23/14	830	1	810	0	0	5850	5110	1	5.75	4.75	1086.7
09/17/14	To	09/23/14	09/24/14	-1340	2	-1380	-970	-1340	4510	3730	1	4	1.25	1099.1
09/18/14	To	09/24/14	09/25/14	-1570	3	-1630	-1460	-1570	2940	2100	5	6	2.75	1081.5
09/19/14	To	09/25/14	09/26/14	-620	3	-680	-520	-620	2320	1420	3	5.5	0.5	1089
09/22/14	To	09/26/14	09/29/14	-1110	1	-1130	-1110	-1110	1210	290	1	3.25	0.5	1087.1
09/23/14	To	09/29/14	09/30/14	1430	1	1410	0	0	2640	1700	1	5.75	0.25	1071.5
09/24/14	To	09/30/14	10/01/14	1330	1	1310	0	0	3970	3010	1	4.25	0.25	1057
09/25/14	To	10/01/14	10/02/14	510	1	490	0	0	4480	3500	1	4	5.5	1066.2
09/26/14	To	10/02/14	10/03/14	1150	2	1110	0	0	5630	4610	1	6	0.25	1073.2
09/29/14	To	10/03/14	10/06/14	1210	1	1190	0	0	6840	5800	1	5.5	1.75	1064
09/30/14	To	10/06/14	10/07/14	-90	3	-150	-490	-820	6750	5650	1	5	0.25	1047.6
10/01/14	To	10/07/14	10/08/14	-3170	2	-3210	-2680	-3170	3580	2440	1	5	6	1067.5
10/02/14	To	10/08/14	10/09/14	950	1	930	0	0	4530	3370	1	5.25	4	1040.8

In-Sample Dates		OOS Date	OOS Date	osnp	ont	NOnp$20	ollt	odd	equity	NetEq	ncy	pntup	pntdn	TF Close
10/03/14	To	10/09/14	10/10/14	-400	3	-460	-600	-600	4130	2910	1	5	0.25	1023.8
10/06/14	To	10/10/14	10/13/14	870	1	850	0	0	5000	3760	1	6	0.25	1019.2
10/07/14	To	10/13/14	10/14/14	80	1	60	0	0	5080	3820	1	5.5	2.5	1035
10/08/14	To	10/14/14	10/15/14	-150	2	-190	-1370	-1370	4930	3630	5	4	0.25	1039.2
10/09/14	To	10/15/14	10/16/14	920	2	880	-750	-750	5850	4510	5	4.75	0.25	1057.7
10/10/14	To	10/16/14	10/17/14	1460	1	1440	0	0	7310	5950	5	3.25	1	1053.6
10/13/14	To	10/17/14	10/20/14	-820	2	-860	-970	-970	6490	5090	3	3.75	2.25	1067.2
10/14/14	To	10/20/14	10/21/14	1190	1	1170	0	0	7680	6260	3	5.25	2.25	1085.3
10/15/14	To	10/21/14	10/22/14	2220	2	2180	0	0	9900	8440	3	5	2.25	1070.1
10/16/14	To	10/22/14	10/23/14	-340	2	-380	-600	-600	9560	8060	5	4.5	2	1089.4
10/17/14	To	10/23/14	10/24/14	40	2	0	-90	-90	9600	8060	1	1	0.25	1090.3
10/20/14	To	10/24/14	10/27/14	-110	2	-150	-360	-360	9490	7910	1	1	0.25	1091.1
10/21/14	To	10/27/14	10/28/14	2530	1	2510	0	0	12020	10420	1	0.75	0.25	1122.6
10/22/14	To	10/28/14	10/29/14	-110	2	-150	-150	-150	11910	10270	1	1	0.25	1116.6
10/23/14	To	10/29/14	10/30/14	-1200	2	-1240	-1220	-1220	10710	9030	1	4	3.5	1128.7
10/24/14	To	10/30/14	10/31/14	-390	2	-430	-270	-390	10320	8600	3	2.5	5.5	1145.9
10/27/14	To	10/31/14	11/03/14	610	1	590	0	0	10930	9190	3	3.75	5.5	1141.2
10/28/14	To	11/03/14	11/04/14	450	2	410	-20	-20	11380	9600	3	3.5	5.25	1137.2
10/29/14	To	11/04/14	11/05/14	-540	1	-560	-540	-540	10840	9040	1	2.75	0.25	1140.6
10/30/14	To	11/05/14	11/06/14	380	1	360	0	0	11220	9400	3	3.5	5.5	1146.3
10/31/14	To	11/06/14	11/07/14	-1000	2	-1040	-800	-1000	10220	8360	3	2.5	5.75	1145
11/03/14	To	11/07/14	11/10/14	-50	2	-90	-280	-280	10170	8270	3	2.5	4.25	1152.1
11/04/14	To	11/10/14	11/11/14	290	1	270	0	0	10460	8540	5	1.5	6	1153.8
11/05/14	To	11/11/14	11/12/14	-100	2	-140	-570	-570	10360	8400	3	0.25	4.75	1160.6
11/06/14	To	11/12/14	11/13/14	-200	2	-240	-650	-650	10160	8160	5	1.25	5.75	1148.1
11/07/14	To	11/13/14	11/14/14	220	1	200	0	0	10380	8360	1	3.75	3.5	1147.8
11/10/14	To	11/14/14	11/17/14	1010	1	990	0	0	11390	9350	1	4	3.5	1139.2
11/11/14	To	11/17/14	11/18/14	-960	2	-1000	-510	-960	10430	8350	1	4	3.5	1142.6
11/12/14	To	11/18/14	11/19/14	230	1	210	0	0	10660	8560	1	4.5	0.25	1132.3
11/13/14	To	11/19/14	11/20/14	880	1	860	0	0	11540	9420	1	4	3.5	1144.3
11/14/14	To	11/20/14	11/21/14	-1150	1	-1170	-1150	-1150	10390	8250	1	4	3.5	1145.5
11/17/14	To	11/21/14	11/24/14	-970	3	-1030	-690	-970	9420	7220	5	5	0.5	1160.4
11/18/14	To	11/24/14	11/25/14	-310	1	-330	-310	-310	9110	6890	1	2.75	3.5	1160.6
11/19/14	To	11/25/14	11/26/14	550	1	530	0	0	9660	7420	1	0.25	3.5	1165.6
11/24/14	To	11/28/14	12/01/14	2400	2	2360	-260	-260	12060	9780	5	0.25	5.25	1127.8
11/25/14	To	12/01/14	12/02/14	260	2	220	-300	-300	12320	10000	5	3.75	2	1142.6
11/26/14	To	12/02/14	12/03/14	1320	2	1280	0	0	13640	11280	1	2.25	0.25	1153.8
11/27/14	To	12/03/14	12/04/14	-1200	2	-1240	-790	-1200	12440	10040	1	3.5	1.25	1148.9
11/28/14	To	12/04/14	12/05/14	-60	2	-100	-110	-110	12380	9940	1	3.5	1.25	1157.2
12/01/14	To	12/05/14	12/08/14	870	2	830	-160	-160	13250	10770	3	3.5	3	1141.1
12/02/14	To	12/08/14	12/09/14	1380	2	1340	-980	-980	14630	12110	3	0.5	5.5	1159.8
12/03/14	To	12/09/14	12/10/14	970	2	930	-530	-530	15600	13040	3	3.5	1.25	1136.6
12/04/14	To	12/10/14	12/11/14	-1670	2	-1710	-1010	-1670	13930	11330	5	3.5	5	1137.3
12/05/14	To	12/11/14	12/12/14	-1210	2	-1250	-810	-1210	12720	10080	5	1.25	5	1121.5
12/08/14	To	12/12/14	12/15/14	1070	2	1030	-430	-430	13790	11110	3	1.5	0.75	1116.9
12/09/14	To	12/15/14	12/16/14	1960	2	1920	0	0	15750	13030	5	4.5	2	1110.6
12/10/14	To	12/16/14	12/17/14	750	2	710	-1240	-1240	16500	13740	3	3	0.75	1150.3
12/11/14	To	12/17/14	12/18/14	-980	2	-1020	-830	-980	15520	12720	3	2	0.25	1168
12/12/14	To	12/18/14	12/19/14	930	3	870	-110	-110	16450	13590	1	5.75	0.25	1172.5
12/15/14	To	12/19/14	12/22/14	490	3	430	-70	-120	16940	14020	5	0.25	3.75	1177.9
12/16/14	To	12/22/14	12/23/14	60	2	20	-90	-90	17000	14040	5	0.75	3.5	1180.8
12/19/14	To	12/25/14	12/26/14	940	2	900	0	0	17940	14940	1	0.5	3.5	1192.5
12/22/14	To	12/26/14	12/29/14	110	2	70	0	0	18050	15010	3	1.25	5.75	1196.2

In-Sample Dates			OOS Date	osnp	ont	NOnp$20	ollt	odd	equity	NetEq	ncy	pntup	pntdn	TF Close
12/23/14	To	12/29/14	12/30/14	-400	3	-460	-280	-400	17650	14550	5	0.25	5.25	1189.6
12/24/14	To	12/30/14	12/31/14	-270	3	-330	-700	-1140	17380	14220	3	5.5	5	1179.9
12/26/14	To	01/01/15	01/02/15	1480	1	1460	0	0	18860	15680	3	6	3.75	1171.4
12/29/14	To	01/02/15	01/05/15	920	1	900	0	0	19780	16580	1	5.5	2.75	1158.3
12/30/14	To	01/05/15	01/06/15	-2110	3	-2170	-2220	-2860	17670	14410	1	1.25	2.25	1136.1
12/31/14	To	01/06/15	01/07/15	630	1	610	0	0	18300	15020	3	5.25	6	1150.8
01/01/15	To	01/07/15	01/08/15	550	2	510	-210	-210	18850	15530	1	2.25	2.25	1170.8
01/02/15	To	01/08/15	01/09/15	890	1	870	0	0	19740	16400	1	4	3.75	1159.7
01/05/15	To	01/09/15	01/12/15	550	2	510	-10	-10	20290	16910	1	2.25	2.25	1156.5
01/06/15	To	01/12/15	01/13/15	-1680	2	-1720	-1520	-1680	18610	15190	3	4.5	4.75	1157
01/07/15	To	01/13/15	01/14/15	-540	1	-560	-540	-540	18070	14630	3	3.25	3.75	1153.2
01/08/15	To	01/14/15	01/15/15	-490	2	-530	-1310	-1310	17580	14100	1	4.5	5.5	1130.6
01/09/15	To	01/15/15	01/16/15	1990	1	1970	0	0	19570	16070	3	5.5	2.5	1151
01/13/15	To	01/19/15	01/20/15	-2550	2	-2590	-1680	-2550	17020	13480	3	5.5	1	1145.8
01/14/15	To	01/20/15	01/21/15	560	1	540	0	0	17580	14020	3	5.5	1.75	1141.7
01/15/15	To	01/21/15	01/22/15	390	2	350	-880	-880	17970	14370	3	5.25	1.75	1167.9
01/16/15	To	01/22/15	01/23/15	-530	2	-570	-380	-530	17440	13800	3	5.5	0.5	1163.6
01/19/15	To	01/23/15	01/26/15	10	3	-50	-460	-460	17450	13750	5	0.75	3.75	1178.5
01/20/15	To	01/26/15	01/27/15	-1860	2	-1900	-1320	-1860	15590	11850	1	2.25	1.75	1174.6
01/21/15	To	01/27/15	01/28/15	330	2	290	-990	-990	15920	12140	1	0.25	2.5	1148.8
01/22/15	To	01/28/15	01/29/15	1990	2	1950	0	0	17910	14090	5	1	2.5	1169
01/23/15	To	01/29/15	01/30/15	1980	1	1960	0	0	19890	16050	1	5.5	2.75	1140.4
01/26/15	To	01/30/15	02/02/15	-690	2	-730	-760	-760	19200	15320	1	5.5	3.25	1153.1
01/27/15	To	02/02/15	02/03/15	320	2	280	-170	-170	19520	15600	1	5.75	0.25	1173.7
01/28/15	To	02/03/15	02/04/15	310	2	270	0	0	19830	15870	1	4.75	2.75	1165.8
01/29/15	To	02/04/15	02/05/15	-520	2	-560	-790	-790	19310	15310	1	5.75	4.75	1182.6
01/30/15	To	02/05/15	02/06/15	1190	2	1150	0	0	20500	16460	5	3.25	0.5	1182.3
02/02/15	To	02/06/15	02/09/15	-1680	2	-1720	-1180	-1680	18820	14740	3	0.5	6	1173.4
02/03/15	To	02/09/15	02/10/15	620	1	600	0	0	19440	15340	1	5	4.75	1178.7
02/04/15	To	02/10/15	02/11/15	-950	4	-1030	-500	-980	18490	14310	3	2	4	1179.5
02/05/15	To	02/11/15	02/12/15	-790	1	-810	-790	-790	17700	13500	3	3.25	5.25	1192
02/06/15	To	02/12/15	02/13/15	500	1	480	0	0	18200	13980	1	6	5.75	1200.2
02/10/15	To	02/16/15	02/17/15	40	1	20	0	0	18240	14000	1	5.75	5.25	1202
02/11/15	To	02/17/15	02/18/15	-530	1	-550	-530	-530	17710	13450	1	4.75	5.25	1204.2
02/12/15	To	02/18/15	02/19/15	-370	1	-390	-370	-370	17340	13060	1	5.75	5	1206.3
02/13/15	To	02/19/15	02/20/15	-1130	3	-1190	-790	-1530	16210	11870	3	0.25	5.5	1206.9
02/16/15	To	02/20/15	02/23/15	520	1	500	0	0	16730	12370	5	0.5	5.25	1209.6
02/17/15	To	02/23/15	02/24/15	210	1	190	0	0	16940	12560	3	2	5.75	1211.6
02/18/15	To	02/24/15	02/25/15	310	1	290	0	0	17250	12850	5	0.5	5.75	1211.6
02/19/15	To	02/25/15	02/26/15	-350	2	-390	-370	-370	16900	12460	3	2.75	4.5	1216.9
02/20/15	To	02/26/15	02/27/15	370	1	350	0	0	17270	12810	1	4.75	5	1210.8
02/23/15	To	02/27/15	03/02/15	-260	2	-300	-560	-560	17010	12510	5	3	5.25	1218.6
02/24/15	To	03/02/15	03/03/15	260	1	240	0	0	17270	12750	1	3	3.75	1211.8
02/25/15	To	03/03/15	03/04/15	-230	1	-250	-230	-230	17040	12500	5	5	0.25	1208.2
02/26/15	To	03/04/15	03/05/15	-320	2	-360	-440	-440	16720	12140	3	3.5	4.5	1211.9
02/27/15	To	03/05/15	03/06/15	1140	1	1120	0	0	17860	13260	3	5	4.5	1197.8
03/02/15	To	03/06/15	03/09/15	-180	2	-220	-160	-180	17680	13040	1	2.75	6	1201.8
03/03/15	To	03/09/15	03/10/15	-540	2	-580	-360	-540	17140	12460	1	3.25	0.25	1186.5
03/04/15	To	03/10/15	03/11/15	250	2	210	-300	-300	17390	12670	1	3.5	0.25	1194.5
03/05/15	To	03/11/15	03/12/15	940	1	920	0	0	18330	13590	5	5.5	3.75	1215.1
03/06/15	To	03/12/15	03/13/15	210	1	190	0	0	18540	13780	1	5.75	1	1210.3
03/09/15	To	03/13/15	03/16/15	330	2	290	0	0	18870	14070	1	1.5	5.5	1216.6
03/10/15	To	03/16/15	03/17/15	320	3	260	-140	-180	19190	14330	3	1	5.75	1221.1

In-Sample Dates			OOS Date	osnp	ont	NOnp$20	ollt	odd	equity	NetEq	ncy	pntup	pntdn	TF Close
03/11/15	To	03/17/15	03/18/15	730	2	690	-350	-350	19920	15020	1	0.5	3	1232.8
03/12/15	To	03/18/15	03/19/15	-320	2	-360	-380	-380	19600	14660	1	3	1	1235.1
03/13/15	To	03/19/15	03/20/15	620	2	580	0	0	20220	15240	1	0.75	5.5	1244.6
03/16/15	To	03/20/15	03/23/15	120	1	100	0	0	20340	15340	1	3.25	5.75	1244.1
03/17/15	To	03/23/15	03/24/15	70	1	50	0	0	20410	15390	3	0.25	1.5	1245.3
03/18/15	To	03/24/15	03/25/15	-1570	2	-1610	-2270	-2270	18840	13780	1	0.25	5.5	1215.2
03/19/15	To	03/25/15	03/26/15	-170	1	-190	-170	-170	18670	13590	1	4.25	6	1211.2
03/20/15	To	03/26/15	03/27/15	510	1	490	0	0	19180	14080	1	2.25	0.5	1218.8
03/23/15	To	03/27/15	03/30/15	750	1	730	0	0	19930	14810	1	4.25	4.75	1235.7
03/24/15	To	03/30/15	03/31/15	-70	2	-110	-90	-90	19860	14700	1	1.5	0.5	1233
03/25/15	To	03/31/15	04/01/15	260	1	240	0	0	20120	14940	1	1.5	0.75	1233.4
03/26/15	To	04/01/15	04/02/15	-40	1	-60	-40	-40	20080	14880	1	2.25	4.25	1236.4
03/30/15	To	04/03/15	04/06/15	990	3	930	-50	-50	21070	15810	1	3	4.25	1241.6
03/31/15	To	04/06/15	04/07/15	160	1	140	0	0	21230	15950	1	5	3.5	1232.2
04/01/15	To	04/07/15	04/08/15	780	1	760	0	0	22010	16710	1	2.25	4.75	1244.4
04/02/15	To	04/08/15	04/09/15	-880	2	-920	-750	-880	21130	15790	1	0.25	4.75	1240.8
04/03/15	To	04/09/15	04/10/15	250	2	210	0	0	21380	16000	1	0.25	5	1246.3
04/06/15	To	04/10/15	04/13/15	-140	1	-160	-140	-140	21240	15840	1	0.25	5	1246.4
04/07/15	To	04/13/15	04/14/15	320	1	300	0	0	21560	16140	1	5.25	0.25	1246.8
04/08/15	To	04/14/15	04/15/15	540	1	520	0	0	22100	16660	1	0.25	5.25	1255.5
04/09/15	To	04/15/15	04/16/15	0	1	-20	0	0	22100	16640	1	5.5	2.25	1254.6
04/10/15	To	04/16/15	04/17/15	1450	2	1410	0	0	23550	18050	3	4	4.75	1233.4
04/13/15	To	04/17/15	04/20/15	170	2	130	-220	-220	23720	18180	1	0.5	4.75	1245.6
04/14/15	To	04/20/15	04/21/15	-350	2	-390	-460	-460	23370	17790	1	1.5	4.75	1244.4
04/15/15	To	04/21/15	04/22/15	-220	1	-240	-220	-220	23150	17550	3	5.5	4.5	1247.2
04/16/15	To	04/22/15	04/23/15	-520	2	-560	-600	-600	22630	16990	3	5.5	3	1251.9
04/17/15	To	04/23/15	04/24/15	310	2	270	-40	-40	22940	17260	1	0.75	0.75	1248.3
04/20/15	To	04/24/15	04/27/15	1820	1	1800	0	0	24760	19060	1	0.25	2	1235.8
04/21/15	To	04/27/15	04/28/15	-410	2	-450	-440	-440	24350	18610	1	0.25	4	1243.6
04/22/15	To	04/28/15	04/29/15	-430	2	-470	-490	-490	23920	18140	1	0.5	5.75	1224.7
04/23/15	To	04/29/15	04/30/15	2090	1	2070	0	0	26010	20210	1	0.5	0.5	1200.5
04/24/15	To	04/30/15	05/01/15	70	2	30	-40	-40	26080	20240	5	5.25	1.75	1208.3
04/27/15	To	05/01/15	05/04/15	0	2	-40	-70	-70	26080	20200	5	5.25	4	1212.4
04/28/15	To	05/04/15	05/05/15	2110	2	2070	0	0	28190	22270	3	0.5	5.25	1198.3
04/29/15	To	05/05/15	05/06/15	1320	2	1280	0	0	29510	23550	1	5.5	0.75	1202.1
04/30/15	To	05/06/15	05/07/15	630	1	610	0	0	30140	24160	3	1.75	5	1207.9
05/01/15	To	05/07/15	05/08/15	150	2	110	0	0	30290	24270	3	1	6	1213.3
05/04/15	To	05/08/15	05/11/15	380	1	360	0	0	30670	24630	1	6	4	1215.5
05/05/15	To	05/11/15	05/12/15	-310	2	-350	-540	-540	30360	24280	3	1	1	1215.3
05/06/15	To	05/12/15	05/13/15	860	2	820	0	0	31220	25100	1	6	2.5	1213
05/07/15	To	05/13/15	05/14/15	490	1	470	0	0	31710	25570	1	4.75	3	1226.5
05/08/15	To	05/14/15	05/15/15	530	3	470	-100	-100	32240	26040	3	1.25	5.5	1225.3
05/11/15	To	05/15/15	05/18/15	1670	1	1650	0	0	33510	27690	3	1.75	6	1239.7
05/12/15	To	05/18/15	05/19/15	-30	1	-50	-30	-30	33880	27640	1	4.75	3	1238.9
05/13/15	To	05/19/15	05/20/15	-200	1	-220	-200	-200	33680	27420	1	1.5	4	1240.3
05/14/15	To	05/20/15	05/21/15	-120	1	-140	-120	-120	33560	27280	1	4.75	5.75	1237.6
05/15/15	To	05/21/15	05/22/15	-490	1	-510	-490	-490	33070	26770	1	4.75	6	1233.7
05/19/15	To	05/25/15	05/26/15	720	1	700	0	0	33790	27470	5	5.75	4	1222.8
05/20/15	To	05/26/15	05/27/15	1110	2	1070	-350	-350	34900	28540	3	5.5	3.75	1237
05/21/15	To	05/27/15	05/28/15	-790	2	-830	-460	-790	34110	27710	1	3.5	3.5	1237
05/22/15	To	05/28/15	05/29/15	560	1	540	0	0	34670	28250	1	2.25	4.75	1228.4
05/25/15	To	05/29/15	06/01/15	-580	2	-620	-440	-580	34090	27630	1	2	4.75	1232.5
05/26/15	To	06/01/15	06/02/15	660	1	640	0	0	34750	28270	1	2.25	4.75	1234.5

In-Sample Dates		OOS Date	osnp	ont	NOnp$20	ollt	odd	equity	NetEq	ncy	pntup	pntdn	TF Close
05/27/15	To	06/02/15	06/03/15	-1510	3	-1570	-1070	-1510	33240	26700	1	2	0.25	1248.4
05/28/15	To	06/03/15	06/04/15	200	2	160	-250	-250	33440	26860	1	4	4.75	1236.2
05/29/15	To	06/04/15	06/05/15	-610	2	-650	-1100	-1100	32830	26210	1	3.5	0.25	1244.5
06/01/15	To	06/05/15	06/08/15	420	2	380	0	0	33250	26590	5	4.25	5.25	1236.4
06/02/15	To	06/08/15	06/09/15	-210	2	-250	-210	-210	33040	26340	1	1.75	5.5	1235
06/03/15	To	06/09/15	06/10/15	1240	2	1200	0	0	34280	27540	3	4.25	5.5	1250.8
06/04/15	To	06/10/15	06/11/15	-190	2	-230	-140	-190	34090	27310	1	3.75	2.25	1251.9
06/05/15	To	06/11/15	06/12/15	80	2	40	0	0	34170	27350	3	4.25	5.75	1249.5
06/08/15	To	06/12/15	06/15/15	1260	1	1240	0	0	35430	28590	3	5.75	6	1244.2
06/09/15	To	06/15/15	06/16/15	1000	1	980	0	0	36430	29570	3	0.25	5.25	1254.9
06/10/15	To	06/16/15	06/17/15	340	2	300	-190	-190	36770	29870	1	3.25	1.5	1251.4
06/11/15	To	06/17/15	06/18/15	1060	1	1040	0	0	37830	30910	5	1	4.75	1269.8
06/12/15	To	06/18/15	06/19/15	80	4	0	-200	-230	37910	30910	5	1	3	1266.5
06/15/15	To	06/19/15	06/22/15	100	1	80	0	0	38010	30990	3	1.25	4	1276.7
06/16/15	To	06/22/15	06/23/15	390	2	350	0	0	38400	31340	5	1	4	1280.7
06/17/15	To	06/23/15	06/24/15	610	2	570	-170	-170	39010	31910	5	3.75	0.5	1269.5
06/18/15	To	06/24/15	06/25/15	-620	3	-680	-490	-970	38390	31230	5	6	0.75	1269.4
06/19/15	To	06/25/15	06/26/15	190	1	170	0	0	38580	31400	1	4.5	4.25	1268.8
06/22/15	To	06/26/15	06/29/15	2550	1	2530	0	0	41130	33530	1	5	3	1234.7
06/23/15	To	06/29/15	06/30/15	20	2	-20	-90	-90	41150	33510	1	3.75	5.25	1239.6
06/24/15	To	06/30/15	07/01/15	-610	1	-630	-610	-610	40540	33280	1	3.5	2.25	1240.7
06/25/15	To	07/01/15	07/02/15	200	1	180	0	0	40740	33460	3	6	2.25	1234
06/29/15	To	07/03/15	07/06/15	-810	1	-830	-810	-810	39930	32630	3	6	2	1235.3
06/30/15	To	07/06/15	07/07/15	-1320	4	-1400	-1150	-1660	38610	31230	5	5.75	0.25	1234.1
07/01/15	To	07/07/15	07/08/15	40	2	0	-540	-540	38650	31230	5	5	0.5	1215.4
07/02/15	To	07/08/15	07/09/15	810	3	750	-120	-120	39460	31980	5	6	0.25	1217.3
07/03/15	To	07/09/15	07/10/15	260	1	240	0	0	39720	32220	1	5.75	0.25	1233.5
07/06/15	To	07/10/15	07/13/15	-480	1	-500	-480	-480	39240	31720	1	6	0.25	1251.2
07/07/15	To	07/13/15	07/14/15	790	1	770	0	0	40030	32490	1	5.25	4	1257.9
07/08/15	To	07/14/15	07/15/15	860	1	840	0	0	40890	33330	1	4	0.5	1252.7
07/09/15	To	07/15/15	07/16/15	-220	1	-240	-220	-220	40670	33090	1	5.75	0.75	1259.5
07/10/15	To	07/16/15	07/17/15	780	2	740	0	0	41450	33830	1	3.5	3.75	1252.2
07/13/15	To	07/17/15	07/20/15	-310	2	-350	-390	-390	41140	33480	1	4.5	1.75	1247.3
07/14/15	To	07/20/15	07/21/15	860	2	820	0	0	42000	34300	1	4.5	0.75	1240.8
07/15/15	To	07/21/15	07/22/15	-90	2	-130	-480	-480	41910	34170	5	5.25	1	1245.3
07/16/15	To	07/22/15	07/23/15	1620	1	1600	0	0	43530	35770	1	5.25	3.25	1231.4
07/17/15	To	07/23/15	07/24/15	1590	1	1570	0	0	45120	37340	3	5.75	4.75	1212.7
07/20/15	To	07/24/15	07/27/15	60	1	40	0	0	45180	37380	1	3.5	0.25	1201.2
07/21/15	To	07/27/15	07/28/15	720	1	700	0	0	45900	38080	3	3	4.75	1209.5
07/22/15	To	07/28/15	07/29/15	270	2	230	-120	-120	46170	38310	1	4.75	1.75	1213.6
07/23/15	To	07/29/15	07/30/15	-850	1	-870	-850	-850	45320	37440	1	4.25	0.75	1219
07/24/15	To	07/30/15	07/31/15	480	1	460	0	0	45800	37900	3	2.5	4	1224.4
07/27/15	To	07/31/15	08/03/15	-70	2	-110	-240	-240	45730	37790	1	0.5	1.5	1218.6
07/28/15	To	08/03/15	08/04/15	-570	2	-610	-470	-570	45160	37180	1	0.5	1.75	1212.9
07/29/15	To	08/04/15	08/05/15	-510	1	-530	-510	-510	44650	36650	1	1	5.75	1218.6
07/30/15	To	08/05/15	08/06/15	-850	2	-890	-1320	-1320	43800	35760	1	2.5	5.75	1201.1
07/31/15	To	08/06/15	08/07/15	1140	3	1080	0	0	44940	36840	5	6	0.25	1193.2
08/03/15	To	08/07/15	08/10/15	450	1	430	0	0	45390	37270	1	3	2	1207.4
08/04/15	To	08/10/15	08/11/15	140	2	100	-80	-80	45530	37370	1	2.5	0.25	1197.2
08/05/15	To	08/11/15	08/12/15	-330	2	-370	-640	-640	45200	37000	1	1	2.75	1195.4
08/06/15	To	08/12/15	08/13/15	-620	1	-640	-620	-620	44580	36360	1	1.75	3	1190.9
08/07/15	To	08/13/15	08/14/15	1550	3	1490	-20	-20	46130	37850	3	3.25	4	1199.3
08/10/15	To	08/14/15	08/17/15	-310	2	-350	-1100	-1100	45820	37500	3	2.5	5.5	1211.9

In-Sample Dates			OOS Date	osnp	ont	NOnp$20	ollt	odd	equity	NetEq	ncy	pntup	pntdn	TF Close
08/11/15	To	08/17/15	08/18/15	-480	2	-520	-510	-510	45340	36980	3	2.25	4.75	1201
08/12/15	To	08/18/15	08/19/15	170	2	130	0	0	45510	37110	3	0.25	4.5	1186.9
08/13/15	To	08/19/15	08/20/15	-610	2	-650	-1220	-1220	44900	36460	3	0.25	6	1155.9
08/14/15	To	08/20/15	08/21/15	590	2	550	0	0	45490	37010	3	0.25	5	1145.1
08/17/15	To	08/21/15	08/24/15	-2490	3	-2550	-3700	-4640	43000	34460	3	3	0.25	1088.6
08/18/15	To	08/24/15	08/25/15	2650	3	2590	-200	-200	45650	37050	3	3	0.25	1098.6
08/19/15	To	08/25/15	08/26/15	-1460	4	-1540	-2730	-3340	44190	35510	3	2.25	0.25	1118.8
08/20/15	To	08/26/15	08/27/15	1270	2	1230	0	0	45460	36740	3	5.25	0.25	1142.7
08/21/15	To	08/27/15	08/28/15	1090	1	1070	0	0	46550	37810	1	2.75	4.25	1153.2
08/24/15	To	08/28/15	08/31/15	160	2	120	0	0	46710	37930	3	5.5	0.25	1146.7
08/25/15	To	08/31/15	09/01/15	-1450	1	-1470	-1450	-1450	45260	36460	1	3.25	5.75	1119.4
08/26/15	To	09/01/15	09/02/15	940	1	920	0	0	46200	37380	1	0.25	4.25	1135
08/27/15	To	09/02/15	09/03/15	-90	2	-130	-330	-330	46110	37250	1	3	5.75	1132.5
08/28/15	To	09/03/15	09/04/15	-130	1	-150	-130	-130	45980	37100	1	2.25	0.25	1125.4
09/01/15	To	09/07/15	09/08/15	870	2	830	-10	-10	46850	37930	1	6	5	1148.5
09/02/15	To	09/08/15	09/09/15	1050	3	990	-470	-470	47900	38920	3	0.25	1.25	1136.9
09/03/15	To	09/09/15	09/10/15	-640	1	-660	-640	-640	47260	38260	1	3.5	4.25	1139.9
09/04/15	To	09/10/15	09/11/15	1250	1	1230	0	0	48510	39490	1	2	1.25	1149.4
09/07/15	To	09/11/15	09/14/15	-900	2	-940	-660	-900	47610	38550	1	0.5	2.5	1142.1
09/08/15	To	09/14/15	09/15/15	-160	2	-200	-600	-600	47450	38350	1	0.75	2.75	1156.2
09/09/15	To	09/15/15	09/16/15	260	2	220	-200	-200	47710	38570	1	2.25	1.5	1166.3
09/10/15	To	09/16/15	09/17/15	70	2	30	-260	-260	47780	38600	1	3.25	4.25	1166.8
09/11/15	To	09/17/15	09/18/15	530	1	510	0	0	48310	39110	1	3.25	2	1157.2
09/14/15	To	09/18/15	09/21/15	950	1	930	0	0	49260	40040	1	3.25	2	1154.8
09/15/15	To	09/21/15	09/22/15	1310	2	1270	0	0	50570	41310	1	3.25	1.75	1134.2
09/16/15	To	09/22/15	09/23/15	-330	2	-370	-400	-400	50240	40940	1	1.5	2.5	1129.1
09/17/15	To	09/23/15	09/24/15	870	2	830	0	0	51110	41770	1	3.25	2.75	1126.7
09/18/15	To	09/24/15	09/25/15	-1950	2	-1990	-2000	-2000	49160	39780	1	5	5	1110.1
09/21/15	To	09/25/15	09/28/15	2030	2	1990	-200	-200	51190	41770	1	5.25	2	1080.4
09/22/15	To	09/28/15	09/29/15	40	2	0	-310	-310	51230	41770	1	5.25	2	1073.5
09/23/15	To	09/29/15	09/30/15	700	2	660	0	0	51930	42430	3	5.75	2.75	1091
09/24/15	To	09/30/15	10/01/15	-2520	3	-2580	-1640	-2710	49410	39850	3	5.25	1.5	1090.2
09/25/15	To	10/01/15	10/02/15	520	3	460	-1240	-1240	49930	40310	3	5.75	0.75	1107.3
09/28/15	To	10/02/15	10/05/15	1580	1	1560	0	0	51510	41870	5	5.75	6	1130.9
09/29/15	To	10/05/15	10/06/15	-1470	2	-1510	-1080	-1470	50040	40360	1	0.75	5	1123.4
09/30/15	To	10/06/15	10/07/15	810	2	770	-260	-260	50850	41130	1	0.75	5.5	1145
10/01/15	To	10/07/15	10/08/15	1310	1	1290	0	0	52160	42420	5	2.75	5	1154.8
10/02/15	To	10/08/15	10/09/15	460	2	420	0	0	52620	42840	1	4.25	0.25	1156.6
10/05/15	To	10/09/15	10/12/15	40	1	20	0	0	52660	42860	1	3.25	2.75	1156.4
10/06/15	To	10/12/15	10/13/15	1280	1	1260	0	0	53940	44120	1	1.25	2.75	1138
10/07/15	To	10/13/15	10/14/15	1160	1	1140	0	0	55100	45260	1	3.5	2.5	1125.8
10/08/15	To	10/14/15	10/15/15	2200	1	2180	0	0	57300	47440	3	0.75	1.25	1157.4
10/09/15	To	10/15/15	10/16/15	-1500	2	-1540	-800	-1500	55800	45900	3	1	5.5	1151.8
10/12/15	To	10/16/15	10/19/15	-380	1	-400	-380	-380	55420	45500	1	1	0.25	1156
10/13/15	To	10/19/15	10/20/15	-10	1	-30	-10	-10	55410	45470	5	1.25	5.75	1152.3
10/14/15	To	10/20/15	10/21/15	-1730	2	-1770	-1880	-1880	53680	43700	5	1.25	5.75	1135.6
10/15/15	To	10/21/15	10/22/15	-10	2	-50	-200	-200	53670	43650	5	1	5.25	1150.1
10/16/15	To	10/22/15	10/23/15	690	1	670	0	0	54360	44320	5	1	5.25	1156.5
10/19/15	To	10/23/15	10/26/15	-10	2	-50	-390	-390	54350	44270	5	5.75	4.25	1150
10/20/15	To	10/26/15	10/27/15	1200	2	1160	0	0	55550	45430	5	5.75	4.75	1137
10/21/15	To	10/27/15	10/28/15	-680	2	-720	-1830	-1830	54870	44710	3	3.25	3.5	1170.8
10/22/15	To	10/28/15	10/29/15	710	2	670	-30	-30	55580	45380	3	4.5	6	1156
10/23/15	To	10/29/15	10/30/15	-70	1	-90	-70	-70	55510	45290	1	0.25	6	1153.4

In-Sample Dates			OOS Date	osnp	ont	NOnp$20	ollt	odd	equity	NetEq	ncy	pntup	pntdn	TF Close
10/26/15	To	10/30/15	11/02/15	2020	1	2000	0	0	57530	47290	1	0.75	5.25	1175.5
10/27/15	To	11/02/15	11/03/15	830	1	810	0	0	58360	48100	1	2.25	3.5	1183
10/28/15	To	11/03/15	11/04/15	870	2	830	0	0	59230	48930	1	2.25	3.5	1181.1
10/29/15	To	11/04/15	11/05/15	350	2	310	0	0	59580	49240	1	3.25	2.5	1182.3
10/30/15	To	11/05/15	11/06/15	1170	1	1150	0	0	60750	50390	1	2.75	5.75	1193.9
11/02/15	To	11/06/15	11/09/15	-830	2	-870	-880	-880	59920	49520	1	4.5	1.75	1175.5
11/03/15	To	11/09/15	11/10/15	-380	2	-420	-410	-410	59540	49100	1	1.75	2	1182.1
11/04/15	To	11/10/15	11/11/15	-1100	1	-1120	-1100	-1100	58440	47980	3	5	5.5	1169.8
11/05/15	To	11/11/15	11/12/15	660	2	620	-280	-280	59100	48600	1	2.25	1.25	1148.2
11/06/15	To	11/12/15	11/13/15	-1390	2	-1430	-970	-1390	57710	47170	3	3.25	5.25	1138.1
11/09/15	To	11/13/15	11/16/15	-900	3	-960	-960	-1420	56810	46210	3	6	1	1147.8
11/10/15	To	11/16/15	11/17/15	-30	2	-70	-180	-180	56780	46140	1	3.75	0.75	1146.1
11/11/15	To	11/17/15	11/18/15	-1180	2	-1220	-1460	-1460	55600	44920	1	2	2.5	1165.5
11/12/15	To	11/18/15	11/19/15	-460	2	-500	-430	-460	55140	44420	3	4	1.75	1158.8
11/13/15	To	11/19/15	11/20/15	270	1	250	0	0	55410	44670	1	2	5.5	1168
11/16/15	To	11/20/15	11/23/15	320	2	280	-90	-90	55730	44950	3	2.75	5.25	1174.4
11/17/15	To	11/23/15	11/24/15	1320	1	1300	0	0	57050	46250	3	0.25	3	1182
11/18/15	To	11/24/15	11/25/15	760	1	740	0	0	57810	46990	3	0.25	5.25	1192
11/23/15	To	11/27/15	11/30/15	-210	2	-250	0	0	57600	46740	1	5.25	1.25	1191
11/24/15	To	11/30/15	12/01/15	-100	2	-140	-230	-230	57500	46600	3	0.25	4.25	1199.2
11/25/15	To	12/01/15	12/02/15	1060	1	1040	0	0	58560	47640	1	1	3.25	1188.8
11/26/15	To	12/02/15	12/03/15	2700	1	2680	0	0	61260	50320	3	2	0.25	1165.4
11/27/15	To	12/03/15	12/04/15	200	3	140	-510	-510	61460	50460	5	3.25	1	1178.6
11/30/15	To	12/04/15	12/07/15	1420	1	1400	0	0	62880	51860	3	3.75	0.75	1160.9
12/01/15	To	12/07/15	12/08/15	-540	2	-580	-640	-640	62340	51280	3	3.75	1.5	1151.5
12/02/15	To	12/08/15	12/09/15	-360	2	-400	-690	-690	61980	50880	3	2.5	0.5	1137.5
12/03/15	To	12/09/15	12/10/15	-1280	2	-1320	-1030	-1280	60700	49560	5	5.5	1.5	1142.3
12/04/15	To	12/10/15	12/11/15	950	4	870	-490	-570	61650	50430	5	0.5	2.5	1117.7
12/07/15	To	12/11/15	12/14/15	1150	2	1110	0	0	62800	51540	5	3.75	1.25	1107.6
12/08/15	To	12/14/15	12/15/15	740	1	720	0	0	63540	52260	1	6	5.75	1128.7
12/09/15	To	12/15/15	12/16/15	1080	2	1040	0	0	64620	53300	5	5.75	1.25	1144.7
12/10/15	To	12/16/15	12/17/15	-1250	2	-1290	-1440	-1440	63370	52010	3	5.5	2.25	1125.7
12/11/15	To	12/17/15	12/18/15	1230	1	1210	0	0	64600	53220	1	6	1.5	1113.8