

Trading the S&P E-Mini 1 min bar Futures With The Least Squares Velocity Strategy

9/1/2010 -5/25/2018

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In our working paper, <http://meyersanalytics.com/publications2/EC1LSqVx-2.pdf>, we examined a trading system for the Euro(EC) that used the velocity of prices fit by a least squares straight line through “N” past prices, to determined buy and sell points. In that paper we examined the out-of-sample returns using a metric combination filter called the Walk Forward Metric Explorer (WFME) with the Least Squares Velocity Strategy applied to the EC 1min price bars from 9/1/2010 to 4/28/2017.

In this paper we will apply the Least Squares Velocity strategy and the WFME metric combination filter to the S&P E-Mini 1min bars from 9/1/2010 to 5/25/2018. In addition, we will apply a new strategy input metric filter called the Walk Forward Input Explorer (WFIMP) and compare the results to the WFME filter.

But first a review as to the logic of the strategy employed. In the previous working paper, we examined a trading system that used the velocity of prices fit by a least squares straight line through “N” past prices, to determined buy and sell points. The reasoning behind this type of system was to only trade when the straight-line slope also called straight-line velocity was above a certain threshold. Many times, during the day prices meandering around without a notable trend. At these times, we do not wish to trade because of the whipsaws losses that occur from this type of price action. When a price trend finally starts, the velocity of that price trend moves above some minimum threshold value. Thus, the velocity system would only issue a trade when certain velocity barriers were crossed.

The Least Squares Velocity

The Least Squares polynomial is determined by minimizing the sum of the squares of the difference between the N prices and the value of the polynomial line.

$$\text{err}^2(t) = [\text{Price}(t) - (a + b * t)]^2 = \text{error squared}$$

$$\text{Minimize}(a, b) \sum_{t=1}^{t=N} \text{err}^2(t)$$

This mathematical technique has an exact solution and dates back to Gauss in the 1800's.

The formula for the straight line is:

$$y = a + b * t$$

where **a** is the initial value of the line, **b** is the slope of the line, and **t** is the time of the bar. The slope **b** is also called the **velocity**. Recall that velocity is defined as the change of position per unit time. Using the formula above an easy way to visualize dy/dt , the derivative of y with respect to t, the velocity would be:

$$\text{Velocity} = [a+b*(t+1)] - [a+b*t] = b$$

If you are fitting the straight line to N prices, then the “Best Fit” coefficients **a** and **b** can be solved for quite easily and are given by

$$a = [2(2N+1)/N(N-1)] \sum_1^N p(t) - [6/(N(N-1))] \sum_1^N t * p(t)$$

$$b = \text{Velocity} = [12/N(N^2 - 1)] \sum_1^N t * p(t) - [6/N(N-1)] \sum_1^N p(t)$$

Where **p(t)** is the price at point **t** and **N** is the number of prices we are using to calculate the coefficients. Here **p(1)** is the first price in the series and **p(N)** is the last price in the series.

Here we will use the **velocity** of the least squares straight line to create a strategy. The least squares velocity has the advantage that it is a natural spurious price noise inhibitor. We can create a strategy such that unless the velocity is greater than some threshold we will not buy or sell. A large percentage of price noise generates a lot of back and forth movements of small magnitudes. Using the least squares velocity, we can filter out many of the small random price noise movements by requiring that the velocity be greater than some threshold before we act.

The Least Squares Velocity Strategy Defined

At each bar we calculate the least squares **velocity** or **b** from the formula above. When the velocity is greater than the threshold amount **vup** we will go long. When the velocity is less than the threshold amount **-vdn** we will go short.

Buy Rule:

IF Velocity is greater than the threshold amount **vup** then buy at the market.

Sell Rule:

IF Velocity is less than the threshold amount **-vdn** then sell at the market.

Intraday Bars Exit Rule:

Close all positions 15 minutes before the ES close at 1515 CST(no trades will be carried overnight).

First Trade of Day Entry Rule:

All trade signals before 30 minutes after the open are ignored. We’ve included this rule because with overnight trading there are often gaps in the open creating immediate strategy buys and sells. Many times, these gaps are closed creating a losing whipsaw trade. In order to avoid the opening gap whipsaw trade problem, we’ve delayed the first trade of the day for 30 minutes until after the opening

Discussion of S&P EMini Futures Prices

The S&P 500 Index E-Mini Future (ES) is traded on the CME Futures Globex Exchange and is traded on a 23-hour basis. We have restricted our study to only trading the ES during the stock market hours of 8:30 to 1500 CST. To test this strategy, we will use 1-minute bar prices of the ES futures contract for the 7.5 years from September 2, 2010 to May 25, 2018

Testing the Least Squares Velocity Strategy(LSqV) Using Walk Forward Optimization

There are three strategy inputs to determine:

1. N , is the look back period to calculate the **LSqV**.
2. vup , the threshold amount that LSqV must be greater than to issue a buy signal
3. vdn , the threshold amount that LSqV must be less than to issue a sell signal

We will test the LSqV strategy with the above ES 1 min bars on a *walk forward basis*, as will be described below.

What Is A Walk Forward Optimization with In-Sample Section and Out-Of-Sample Sections?

Whenever we do a TradeStation(TS) or MultiCharts(MC) optimization on a number of different strategy inputs, TS/MC 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 an *in-sample(IS) 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(OOS) 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 price 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 in general 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 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. 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 strategy 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 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 losses 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 week-to-week 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 (>30) 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 Strategy Parameters Using Walk Forward Optimization

There are three strategy parameters to find N , vup and vdn .

For the test data we will run the TradeStation optimization engine on ES 1min price bars from 9/2/2010 to 5/25/2018 with the following optimization ranges for the Least squares velocity strategy inputs. I will create a 30-calendar day in-sample periods each followed by a 7 day out-of-sample period (See Table 1 for the in-sample/out-of-sample periods). This will create 399 in-sample 30-day periods followed by 399 out-of-sample 7-day periods from 9/2/2010 to 5/25/2018.

I will use the following strategy input optimization ranges.

N from 10 to 70 in steps of 10

vup from 0.2 to 3.6 steps of 0.2

vdn from 0.2 to 3.6 in steps of 0.2

Mult= $1.31*\sqrt{N}$. Note: this normalizes the Velocity range for each N to one standard deviation. Else the Velocity would have different ranges for different N and it would be difficult to find a vup and vdn that worked for all N ranges. See Appendix for a detailed explanation.

This will produce 2268 different input combinations or cases of the strategy input parameters. for each of the 399 in-sample/out-of-sample files for the approximately 8 years of 1 min bar ES prices from 9/2/2010 to 5/25/2018.

The question we are attempting to answer statistically is which performance metric or combination of performance metrics (which we will call a *filter*) applied to the in-sample section will produce in-sample strategy inputs that produce statistically valid average 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/MC does an optimization 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.

The combination metric filters are found by a program called WFME64 v8x. Details of this program can be found at <http://meversanalytics.com/wfme.html>.

We will use the WFME64 v8x program to find in-sample combination metric filters which are applied to the out-of-sample data from the ES data from 9/2/2010 to 5/26/2017. This will consist 347 in-sample and out-of-sample sections We will leave the 52 sections of ES data from 6/2/2017 to 5/25/2018 out of the WFME64 calculations so that we can see how the metric filters found by the WFME64 performed on these 52 following *future* weeks which was not included in the WFME64 run.

Here is a metric combination *filter* found by the WFME64 v8x program that was used in of this paper. 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 $pf > 2$. In addition, we wish to limit the number losing trades in a row (**lr**) in the IS period to 4 or less ($lr \leq 3$). Using the **pf-lr** elimination screen, as described, there can still be 100's of rows left in the in-sample section. The PWFO generates the performance metric named **m(p-rd)**. This metric is the **Median of All Trades(Final Trade Profit Minus Maximum Trade Rundown)**. This statistic measures the difference between the final profit of each trade and the maximum trade loss (rundown) of the trade. The farther the final trade profit is from the maximum trade rundown, the better the performance of the input variable. Thus, we would want the median to be as large as possible. We use the median for this statistic, because we do not want this statistic distorted by a few outlier trades Let us choose the 20 rows in the in-sample section that contain the **maximum m(p-rd)** values from the rows that are left from the **pf-lr** screen. In other words, we sort **m(p-rd)** from high to low, eliminate the rows that have $lr > 3$, and $pf > 2$ and then choose the largest **m(p-rd)** 20 Rows of whatever is left. This filter will now leave 20 cases or rows in the in-sample section that satisfy the above filter conditions. We call this filter **t20m(p-rd) |p≤2|lr≤3** where **t20m(p-rd)** means the top or maximum 20 **m(p-rd)** rows left *after* the **pf-lr** in-sample row elimination. Suppose for this filter, within the 20 in-sample rows that are left, we want the row that has the lowest value of the metric called **std**. **std** is the Standard Deviation of all trades in the in-sample section for a given set of strategy inputs. We abbreviate this final filter as **t20m(p-rd) |p≤2|lr≤3-std**. For each in-sample section this filter leaves only one row in the in-sample section with its associated strategy inputs and following out-of-sample net profit in the out-of-sample section using the strategy inputs found in the in-sample section. This **t20m(p-rd) |p≤2|lr≤3-std** filter is then applied to each of the 347 in-sample sections which give 347 sets of strategy inputs that are used to produce the corresponding 347 out-of-sample performance results. The average out-of-sample performance is calculated from these 347 out-of-sample performance results. In addition, many other important out-of-sample performance statistics for this filter are calculated and summarized.

Figure 3 shows such a computer run along with a small sample of other WFME64 filter combinations that are constructed in a similar manner. **Row 4** of the sample output in **Figure 3** shows the results of the filter discussed above.

We also will use a program called **WFINP64 v8x**. Details of this program can be found at <http://meyersanalytics.com/wfinp64v8x.html>. Briefly what this program does is attempt to find a set of strategy inputs in the in-sample section that satisfy a few metric screens. If the strategy inputs satisfy the in-sample metric screens, then the strategy inputs are used to trade the following out-of-sample section. If the strategy inputs do not satisfy the in-sample metric screens, then no trades will be done in the following out-of-sample section. Here is a *input/filter* combination found by the WFINP64 program that was used in of this paper.

70|2|2.8|pf≤5.5|lr≤3. 70|2|2.8| are the strategy inputs, **N, vup and vdn**. If in the in-sample section those strategy inputs generate a $pf \leq 5.5$ AND an $lr \leq 3$, then this set of strategy inputs are used to trade the following out-of-sample data. If in the in-sample section these strategy inputs do not generate a $pf \leq 5.5$ and an $lr \leq 3$ then no trades will be made in the following out-of-sample section. The logic being, as I said above, that 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 when the $pf > 5.5$, we don't wish to trade the out-of-sample section. **lr** is the losing trades in a row (**lr**) in the in-sample section for a given set of strategy inputs. The logic being that we do not wish to trade in the out-of-sample section if the losers-in-a-row in the in-sample section are too many.

Figure 4 shows such a computer run along with a small sample of other strategy WFINP64 *input/filter* combinations that are constructed in a similar manner. **Row 11** of the sample output in **Figure 4** shows the the filter used in this paper.

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's how the bootstrap technique is applied. Suppose as an example, we have 500 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 500 files. We repeat this random picking in each of the 500 files 5000 times. Each of the 5000 mirror filters will choose a random row's OSNP of their own in each of the 500 files. At the end, each of the 5000 mirror filters will have 500 *random* OSNP's picked from the rows of the 500 files. The sum of the 5000 random OSNP picks for each mirror filter will generate a random total out-of-sample net profit (**toNP**) or final random equity. The average and standard deviation of the 5000-mirror filter's different random **toNPs** will allow us to calculate the chance probability of our above chosen filter's toNP. Thus, given the mirror filter's bootstrap random toNP average and standard deviation, we can calculate the probability of obtaining our chosen filter's toNP by pure chance alone. **Figure 3** lists the 5000-mirror filter's bootstrap average for our 347 out-of-sample files of **(\$92.5)** with a bootstrap standard deviation of **\$46.8**. (Side Note. The average is the average per out-of-sample period(weekly). So, the average for the random selection would be the random (Average Random toNP/347) and the average net weekly for the filter from **Figure 3, Row 4** would be the filter toNP/ (# of OOS) periods traded or $38529/261=147.6$. The probability of obtaining our filters average weekly net profit of **147.6** is 1.44×10^{-7} which is **5.1** standard deviations from the bootstrap average. For our filter, in Row 4 , the expected number of cases that we could obtain by pure chance that would match or exceed **\$147.6** is $[1-(1- 1.44 \times 10^{-7})^{30752}] \approx 30752 \times 1.44 \times 10^{-7} = 0.004$ where **30752** is the total number of different filters we looked at in this run. This number is much 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 WFME64 filter on the 347 weeks ending 10/6/2010 – 5/26/2017 and the equity curve on the 52 weeks following until 5/25/2018 (note the first month starting 9/2/2010 was part of the first 30 day in-sample period). The equity curves are 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 ES weekly closing prices superimposed on the Equity Chart. The vertical dotted red line on the right separates the future excluded period equity from 6/06/17 to 5/25/18. This is what would

have happened if you used the **t20m(p-rd) |p<2|lr<3-std** filter found by the WFME64 on *future* data not included in the 10/6/2010 – 5/26/2017 run.

Figure 2 presents a graph of the equity curve generated by using the WFINP64 filter on the 347 weeks ending 10/6/2010 – 5/26/2017 and the equity curve on the 52 weeks following until 5/25/2018 (note the first month starting 9/2/2010 was part of the first 30 day in-sample period). 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 ES weekly closing prices superimposed on the Equity Chart. The vertical dotted red line on the right separates the future excluded period equity from 6/06/17 to 5/25/18. This is what would have happened if you used the **70|2|2.8|pf<5.5|lr<3** filter found by the WFINP64 on *future* data not included in the 10/6/2010 – 5/26/2017 run.

Figure 5 presents the out-of-sample 1-minute bar chart of all the buy and sell signals of the WFME64 filter 4/30/18 to 5/4/18 with the LSQV Indicator or those dates.

Figure 6 presents the out-of-sample 1-minute bar chart of all the buy and sell signals of the WFINP64 filter 4/30/18 to 5/4/18 with the LSQV Indicator or those dates.

Table 1 below presents a table of the 347 and the 52 future weeks in-sample and out-of-sample windows, the WFME **Filter** selected, strategy inputs and the weekly out-of-sample profit/loss results using the filter described above.

Table 2 below presents a table of the 347 and the 52 future weeks in-sample and out-of-sample windows, the WFINP **Filter** selected, strategy inputs and the weekly out-of-sample profit/loss results using the filter described above.

Discussion of Strategy Performance of the WFME64 run

In **Figure 3, Row 4** is the filter chosen in the previous paper, **t20m(p-rd) |p<2|lr<3-std**. The spreadsheet columns present some statistics that are of interest for the filter. An interesting statistic is **Blw**. **Blw** is the maximum number of weeks the **OOS** equity curve for this filter failed to make a new high. **Blw** is 29 weeks for this filter. This means that 29 weeks was the longest time that the equity for this strategy failed to make a new equity high in the 347 out-of-sample weeks. For this strategy, the **%P** (% of oos periods that are positive) was 58%, and the **%Wtr** (The % of all oos trades that are positive) was 54%. This low **%Wtr** was made up for by **oW/oL** (average oos winning trades/average oos losing trades) equal to 1.21.

To see the effect of walk forward analysis, look at **Table 1**. Notice how the input parameters **N**, **vup**, **vdn** 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 addition, notice how often **N** changes from 10 to 70. When the data gets very noisy with a lot of spurious price movements, the look back period, **N**, should be higher. During other times when the noise level is not as much **N** can be lower to get onboard a trend faster.

Figure 1 presents a graph of the equity curve using the filter on the 347 weeks of out-of-sample data. Notice how the equity curve follows the 2nd order polynomial trend line with an **R²** of 0.98. This **R²** dropped to 0.97 for the net equity curve.

Using this filter, the strategy generated a profit of \$38,529 net equity after commissions and slippage of \$20/trade trading one ES contract for 347 weeks. From **Table 1**, the largest losing week was -\$3250 on the week ending 1/8/2016. The largest drawdown was -\$3513 from the week ending on 4/4/14 to 8/1/14. This drawdown lasted 17 weeks and took 12 weeks to recover and made a new equity. The *future* period that was not included in the WFME64 run from 1/26/18 to 5/25/18 was a volatile whipsaw market with the S&P E-Mini dropping from 2879 to 2624 in two weeks then rallying to 2788 in 4 weeks and then dropping to 2605 in 4 weeks and then rallying to 2718 in 7 weeks ending on 5/25/18. Yet the LSQV strategy/WFMEfilter did well making a net profit of \$400 during that time.

Lastly, as can be seen in **Figure 3**, the top 10 filters all did very well in the 52 *future* weeks from 6/2/2017 to 5/25/2018 following the original analysis.

In observing Table 1 we can see that this strategy and filter made trades from a low of no trades in 86 of the 347 weeks to a high of 19 trades/week with an average of 3 trades/week in the weeks it did trade.

Discussion of Strategy Performance of the WFINP64 run

In **Figure 4, Row 11** is the filter chosen in the previous paper, $70|2|2.8|pf<5.5|lr<3$. The spreadsheet columns present some statistics that are of interest for the filter. An interesting statistic is **Blw**. **Blw** is the maximum number of weeks the **OOS** equity curve for this filter failed to make a new high. **Blw** is 28 weeks for this filter. This means that 28 weeks was the longest time that the equity for this strategy failed to make a new equity high in the 347 out-of-sample weeks. For this strategy, the **%P** (% of oos periods that are positive) was 66%, and the **%Wtr** (The % of all oos trades that are positive) was 59%. The average oos winning trades/average oos losing trades (**oW/oL**) is equal to 1.16.

Figure 2 presents a graph of the equity curve using the filter on the 347 weeks of out-of-sample data. Notice how the equity curve follows the 2nd order polynomial trend line with an R^2 of 0.96. This R^2 dropped to 0.95 for the net equity curve.

Using this filter, the strategy generated a profit of \$47,560 net equity after commissions and slippage of \$20/trade trading one ES contract for 347 weeks. From **Table 2**, the largest losing week was -\$3150 on the week ending 1/8/2016. The largest drawdown was -\$3200 from the week ending on 1/3/16 to 1/8/16. This drawdown lasted 1 week and took 3 weeks to recover and made a new equity. The *future* period that was not included in the WFINP64 run from 1/26/18 to 5/25/18 was a volatile whipsaw market with the S&P E-Mini dropping from 2879 to 2624 in two weeks then rallying to 2788 in 4 weeks and then dropping to 2605 in 4 weeks and then rallying to 2718 in 7 weeks ending on 5/25/18. Yet the LSQV strategy/WFINPfilter did very well making a net profit of \$9300 during that time.

Lastly, as can be seen in **Figure 4**, the top 15 filters all did very well in the 52 *future* weeks from 6/2/2017 to 5/25/2018 following the original analysis.

In observing Table 1 we can see that this strategy and filter made trades from a low of no trades in 145 of the 347 weeks to a high of 10 trades/week with an average of 2.5 trades/week in the weeks it did trade.

Comparison of the WFME64 Filter Results and WFINP64 Filter Results

For the period 10/8/10 to 5/26/17 the WFINP64 filter generated \$47,560 in net profits with 514 trades compared to the \$38,529 net profits with 783 trades of the WFME filter. So clearly the WFINP filter was superior to the WFME filter over this period. In addition, 66% of the weekly WFINP filter periods and 59% of the WFINP filter trades were profitable vs only 58% of the weekly WFME filter periods and 54% of the WFME filter trades. In addition, although this may be due to chance, the WFINP filter made \$9571 net profit with 111 trades during the *future* period from 5/26/17 to 5/25/18 while the WFME filter made \$3978 net profit with 195 trades.

As an aside if one held one E-Mini contract from 10/8/10 to 5/25/18 one would have made \$86,225 vs the WFINP filter \$57,131 net profit and the WFME filter \$42,507 net profit.

Figure 1 Graph of Least Squares Velocity Strategy Net Equity Applying the WFME64 Filter Each Week on Out-Of-Sample ES 1min Bar Prices 10/08/2010 to 5/26/2017 -> 5/25/2018

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 of \$20/round trip trade and the green dots are the new highs in net equity. The grey line is the ES Daily Closing prices superimposed on the Equity Chart. The vertical dotted red line on the right separates the future excluded period equity from 5/26/17 to 5/25/18. This is what would have happened if you used $t20m(p-rd)|p<2|lr<3\text{-std}$ on future data 5/26/2017-5/25/18 which was not included in the WFME filter run.

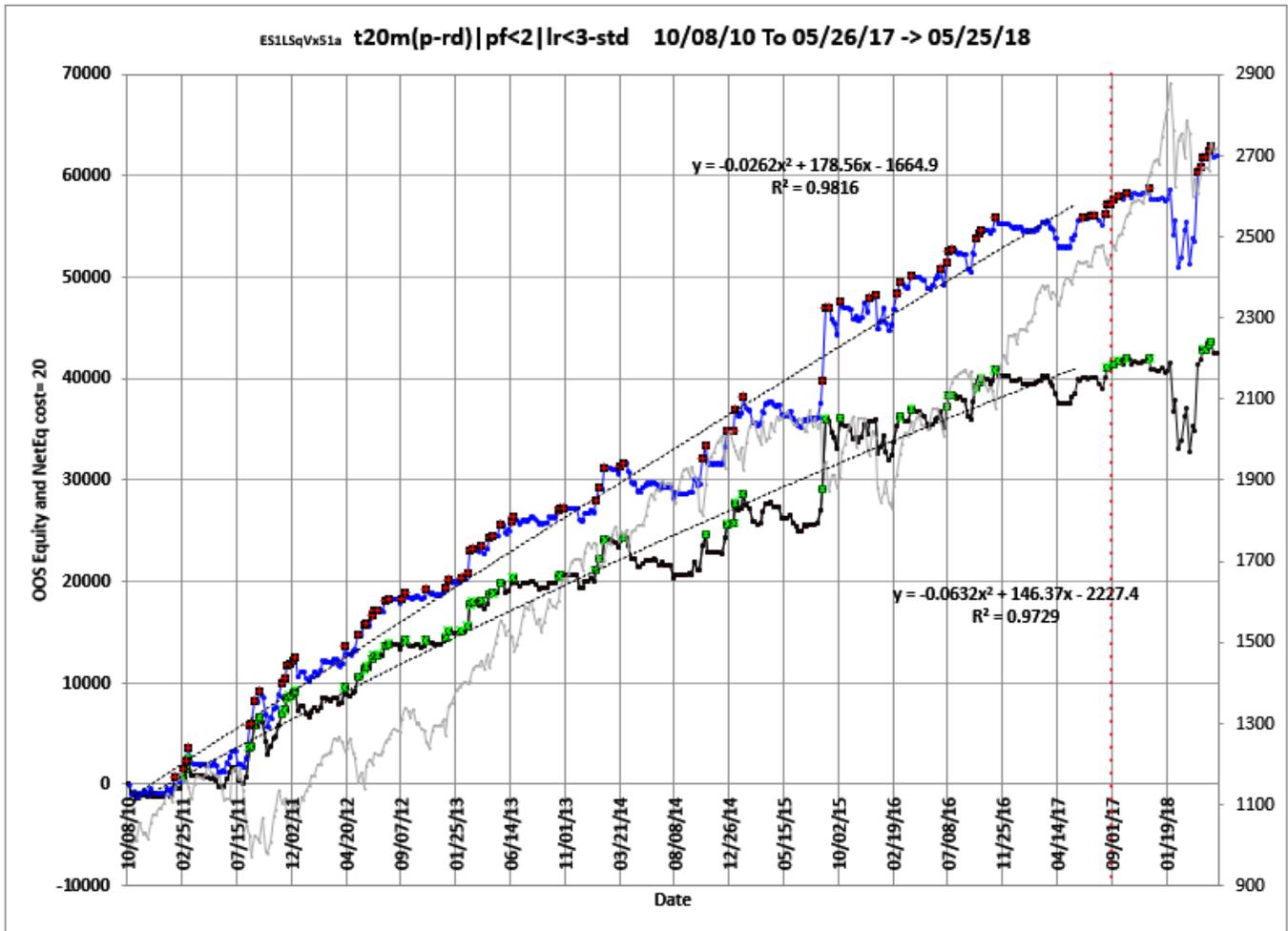


Figure 2 Graph of Least Squares Velocity Strategy Net Equity Applying the WFINP64 Filter Each Week on Out-Of-Sample ES 1min Bar Prices 10/08/2010 to 5/26/2017 -> 5/25/2018

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 of \$20/round trip trade and the green dots are the new highs in net equity. The grey line is the ES weekly Closing prices superimposed on the Equity Chart. The vertical dotted red line on the right separates the future excluded period equity from 5/26/17 to 5/25/18. This is what would have happened if you used 70|2|2.8|pf<5.5|lr<3 filter on future data 6/2/2017-5/25/18 which was not included in the WFINP64 filter run.

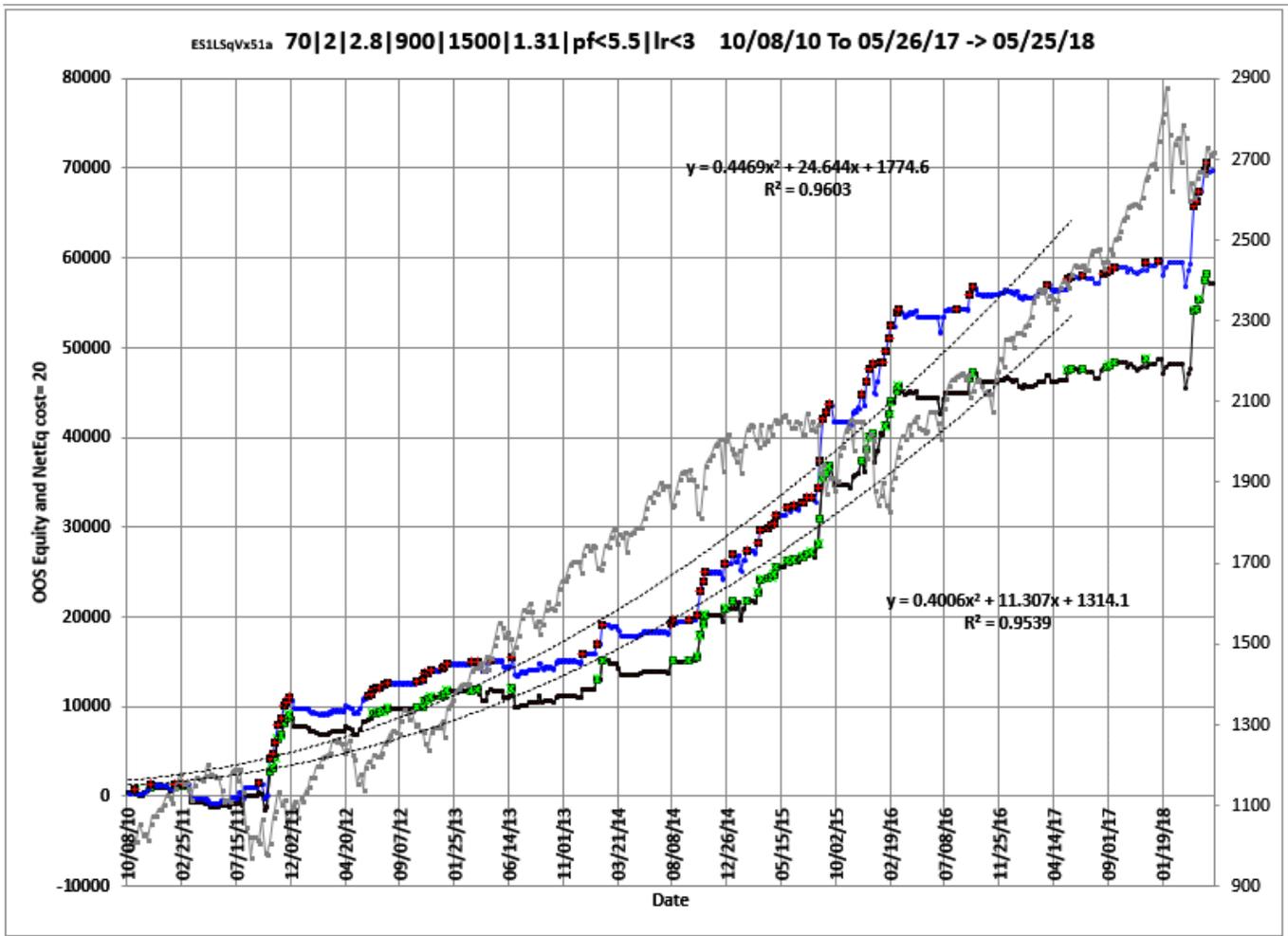


Figure 3 Partial output of the Walk Forward Metric Explorer (WFME64 v8X)
ES-Mini 1 min bars Least Squares Velocity System

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	ES1LsqVx51a	s10/08/10	e05/26/17	#347	AnyTnp	#52							
2	Filter-Metric	toGP	toNP	aoGP	aoTr	ao#T	std	skew	kur	t	oW oL	%Wtr	%P
3	t20eq2A pf<2 lr<5-m(ru-p)	52581	39041	220	77.7	2.8	992	2.274	17.04	3.43	1.36	52	57
4	t20m(p-rd) pf<2 lr<3-std	54169	38529	208	69.3	3	941	1.600	14	3.56	1.21	54	58
5	t20eq2A pf<2 -m(ru-p)	49844	36544	210	75.0	2.8	929	2.385	20.04	3.48	1.33	52	58
6	t20eq2A pf<4 lr<5-PF	47983	35963	200	79.8	2.5	870	2.693	19.22	3.56	1.37	52	55
7	t20eq2A pf<2 lr<4-m(ru-p)	49280	35700	207	72.6	2.9	957	2.590	19.12	3.34	1.35	52	55
8	t20eq2A pf<4 -PF	47496	35496	198	79.2	2.5	877	2.625	18.67	3.5	1.36	52	55
9	t20m(p-rd) pf<2 lr<4-std	50533	34933	194	64.8	3	886	2.115	16.64	3.53	1.2	53	57
10	t20eq2A pf<4 lr<5-m(ru-p)	45884	34084	193	77.8	2.5	866	2.968	21.14	3.43	1.35	52	55
11	t20m(p-rd) pf<2 lr<5-std	49331	33731	189	63.2	3	887	2.117	16.59	3.44	1.21	53	57
12	t20m(p-rd) pf<2 -std	49331	33731	189	63.2	3	887	2.117	16.59	3.44	1.21	53	57

	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
1	a(92.5)	s46.8	f30752					c=\$20						s06/02/17	e05/25/18	#52				t399
2	Lltr	Llp	eqDD	wpr	lpr	#	eqA2	Dev^2	KTau	eqR2	Blw	BE		toGPx	toNPx	aoTRx	aoNTx	#x	tOnpNet	Prob
3	-1800	-3450	-4403	9	6	239	0.75	5456	88	91	65	126		9027	5467	51	4.9	36	44508	2.29E-08
4	-1950	-3250	-3513	10	5	261	-0.05	2338	93	98	29	116		7718	3978	41	4	47	42507	1.44E-07
5	-1800	-3450	-5203	9	6	237	0.46	4573	88	93	65	122		10801	7601	68	4.7	34	44145	6.78E-08
6	-1800	-2088	-4539	13	8	240	1.03	6673	80	84	83	117		7502	4442	49	4.1	37	40405	1.12E-07
7	-1800	-3325	-4341	8	6	238	0.78	5387	88	91	42	133		4365	945	26	4.8	36	36645	1.10E-07
8	-1800	-2088	-4539	13	8	240	1.02	6621	80	84	83	121		5176	2416	38	3.7	37	37912	1.40E-07
9	-1950	-1888	-3450	10	5	261	-0.06	1984	93	99	29	118		9601	5941	52	3.9	47	40874	6.61E-07
10	-1988	-2088	-6377	12	4	238	1.16	6959	86	83	64	126		2525	(895)	15	4.8	36	33189	2.37E-07
11	-1950	-1888	-3627	8	5	261	-0.01	1963	93	98	29	124		12164	8624	69	3.8	46	42355	1.08E-06

Figure 4 Partial output of the Walk Forward Input Explorer (WFIMP64 v8X)
ES-Mini 1 min bars Least Squares Velocity System

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	ES1LsqVx51a	s10/08/10	e05/26/17	#347	AnyTnp	#52							
2	N vup vdn xop xt mult <PF<LR	toGP	tONP	aoGP	aoTr	ao#T	std	skew	kur	t	oW oL	%Wtr	%P
3	70 2 2.8 900 1500 1.31 pf<5.5 lr<4	61391	50051	282	108.3	2.6	913	0.838	7.91	4.55	1.15	58	66
4	70 2 2.8 900 1500 1.31 pf<6 lr<4	61040	49480	275	105.6	2.6	906	0.862	8.03	4.52	1.16	58	64
5	70 2 2.6 900 1500 1.31 pf<5.5 lr<3	60368	49328	290	109.4	2.7	875	1.245	8.36	4.79	1.17	58	64
6	70 2 2.6 900 1500 1.31 pf<6 lr<3	60268	49148	287	108.4	2.6	878	1.211	8.21	4.74	1.17	58	64
7	70 2 2.8 900 1500 1.31 pf<5 lr<4	59953	48913	283	108.6	2.6	922	0.832	7.82	4.47	1.15	58	66
8	70 2 2.6 900 1500 1.31 pf<5 lr<3	58567	47767	289	108.5	2.7	882	1.248	8.3	4.66	1.17	58	64
9	70 2 2.8 900 1500 1.31 pf<5.5 lr<5	59441	47681	261	101.1	2.6	908	0.835	7.86	4.33	1.16	57	64
10	70 2 2.8 900 1500 1.31 pf<5.5	59441	47681	261	101.1	2.6	908	0.835	7.86	4.33	1.16	57	64
11	70 2 2.8 900 1500 1.31 pf<5.5 lr<3	57840	47560	286	112.5	2.5	893	0.908	8.52	4.56	1.16	59	66
12	70 2 2.6 900 1500 1.31 pf<5.5 lr<4	59519	47539	267	99.4	2.7	877	1.124	8.1	4.54	1.15	57	63
13	70 2 2.6 900 1500 1.31 pf<6 lr<4	59419	47359	264	98.5	2.7	880	1.096	7.96	4.5	1.15	57	63
14	70 2 2.8 900 1500 1.31 pf<6	59090	47110	255	98.6	2.6	902	0.858	7.98	4.3	1.16	57	63
15	70 2 2.8 900 1500 1.31 pf<6 lr<5	59090	47110	255	98.6	2.6	902	0.858	7.98	4.3	1.16	57	63

	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
1	a(92.4)	s47.2	f113399					c=\$20						s06/02/17	e05/25/18	#52				t399
2	Lltr	Llp	eqDD	wpr	lpr	#	eqA2	Dev^2	KTau	eqR2	Blw	BE		toGPx	toNPx	aoTRx	aoNTx	#x	tOnpNet	Prob
3	-1825	-3150	-3539	12	5	218	1.1	6604	93	90	46	73		12554	9974	97	3.5	37	60025	4.48E-12
4	-1825	-3150	-3539	12	5	222	1.09	6553	93	90	46	74		12554	9974	97	3.5	37	59454	1.19E-11
5	-1550	-2650	-2902	12	4	208	1.01	6303	92	90	49	66		8862	6882	90	3	33	56210	1.45E-12
6	-1550	-2650	-2902	12	4	210	1.06	6440	91	90	49	68		8862	6882	90	3	33	56030	2.31E-12
7	-1825	-3150	-3539	12	5	212	1.1	6514	93	89	46	76		12554	9974	97	3.5	37	58887	3.79E-12
8	-1550	-2650	-2902	12	4	203	1	6106	92	90	49	70		9225	7265	94	3.1	32	55032	1.91E-12
9	-1825	-3150	-3551	12	6	228	1.03	6441	91	90	46	80		16880	13640	104	4	41	61321	8.36E-11
10	-1825	-3150	-3551	12	6	228	1.03	6441	91	90	46	80		16880	13640	104	4	41	61321	8.36E-11
11	-1825	-3150	-3200	12	6	202	0.89	5495	93	92	28	73		11791	9571	106	3.1	36	57131	1.87E-12
12	-1550	-2650	-3263	12	5	223	1.04	6391	92	90	41	73		10063	7683	85	3.2	37	55222	4.75E-11
13	-1550	-2650	-3263	12	5	225	1.08	6543	92	90	41	74		10063	7683	85	3.2	37	55042	6.93E-11
14	-1825	-3150	-3551	12	6	232	1.02	6389	91	90	46	81		16880	13640	104	4	41	60750	1.92E-10
15	-1825	-3150	-3551	12	6	232	1.02	6389	91	90	46	81		16880	13640	104	4	41	60750	1.92E-10

The WFME64 v8X AVE File Output Cols are defined as follows

❖ Row 1 Columns:

A=The PWFO Stub, **B**=File Start Date, **C**=File End Date, **D**= Number of oos periods (in this example weeks), **N**= Bootstrap average, **O**= Bootstrap Standard Deviation, **P**=Number of filters run, **U**= Cost/trade

❖ Row 1 and Row 2 Columns AA, AB,AC,AD,AE Future Results Not Included in the WFME64 Run. These set of results show how it would turn out if the Strategy Inputs/Filter was used on pwfo files not included in the WFME64 run.

Row 1 Col AA: Future PWFO File Start Date

Row 1 Col AB: Future PWFO File End Date

Row 1 Col AC: Future Number of PWFO Files not included in the WFME64 run (in this example weeks)

Row 1 Col AG: Number of Total oos+future PWFO Files

Row 2 Col AA: **toGPx** Total gross profit for the 52 future excluded periods (for this run periods = weeks).

Row 2 Col AB: **toNPx** Total Net profit (toGP-Number Of Trade Weeks*cost) for the 52 future excluded periods.

Row 2 Col AC: **aoTrx** Average profit per trade for the 52 future excluded periods

Row 2 Col AD: **aoNTx** Average number of trades per week for the 52 future excluded periods

Row 2 Col AE: **#x** The number of the 52 future excluded periods this strategy/filter traded. Note for some periods there can be no strategy inputs/filter that satisfy the Strategy Inputs/Filter criteria and no trades will be made during that period.

❖ Row 2 to Last Row Columns: A through AG

Col A: **The Strategy Input/Filter Names** Example Row 3: **t50mLTr|lr<3r2<80|nt>5-mDev**.

Col B: **toGP** - Total out-of-sample(oos) gross profit for these 347 oos periods (= weeks).

Col C: **toNP** - Total out-of-sample(oos) Net profit (toGP-Number of Trade Weeks*cost) for the 347 oos periods.

Col D: **aoGP** - Average oos gross profit for the 347 oos periods

Col E: **aoTr** - Average oos profit per trade

Col F: **ao#T** - Average number of oos trades per week

Col G: **std** - he standard deviation of the 347 oos period profits and losses

Col H: **skew** - The Skew statistic of the 347 oos period profits and losses

Col I: **kur** - he kurtosis statistic of the 347 oos period profits and losses

Col J: **t** - The student t statistic for the 347 oos periods. The higher the t statistic the higher the probability that this result was not due to pure chance

Col K: **oW/oL** - Ratio of average oos winning trades divided by average oos losing trades.

Col L: **%Wtr** - he percentage if oos winning trades

Col M: **%P** - percent of all oos periods that were profitable.

Col N: **LLtr** - The largest losing oos trade in all oos periods

Col O: **LLp** - The largest losing oos period

Col P: **eqDD** - The oos equity drawdown

Col Q: **wpr** - The largest number of winning oos periods (weeks) in a row.

Col R: **lpr** - he largest number of losing oos periods in a row

Col S: **#** - The number of oos periods this filter produced any profit or loss. Note for some oos periods there can be no strategy inputs that satisfy a given filters criteria and no trades will be made during that period.

Col T: **eqA2** - The acceleration of a 2nd order polynomial fit to the oos equity curve.

Col U: **Dev^2** - measure of equity curve smoothness. The square root of the average (equity curve minus a straight line)^2)

Col V: $K\tau^2$ - The Kendall rank coefficient is often used as a test statistic in a statistical hypothesis test to establish whether two variables may be regarded as statistically dependent. This test is non-parametric, as it does not rely on any assumptions on the distributions of X or Y or the distribution of (X,Y)

Col W: eqR^2 - The correlation coefficient(R^2) of a straight line fit to the equity curve.

Col X: Blw - The maximum number of oos periods the oos equity curve failed to make a new high.

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

Col AA: $toGPx$ - Total gross profit for the 53 future excluded periods(for this run periods = weeks).

Col AB: $toNPx$ - Total Net profit($toGP$ -Number Of Trade Weeks*cost) for the 53 future excluded periods.

Col AC: $aoTRx$ - Average profit per trade for the 252 future excluded periods

Col AD: $aoNTx$ - Average number of trades per week for the 52 future excluded periods

Col AE: $\#x$ - The number of the 52 future excluded periods this strategy/filter traded. Note for some periods there can be no strategy inputs/filter that satisfy the Strategy Inputs/Filter criteria and no trades will be made during that period.

Col AG: $tOnpNet$ - $toNP+toNPx$ = Total Net Profits of oos+future periods

Col AH: $Prob$ - The probability that the filters toNP was due to pure chance. Row 1 lists the random bootstrap average for the 347 out-of-sample files of (\$417.4) with a bootstrap standard deviation of \$105.1. (Note. The average for the random selection is computed as the Average Random toNP/347) The average net weekly for the filter would be the filter toNP/ (# of OOS) periods traded or $121519/357=340.4$. The probability of obtaining our filters average weekly net profit of 340.4 is 2.77×10^{-13} which is 7.2 standard deviations from the bootstrap average. For our filter, in row 6 , the expected number of cases that we could obtain by pure chance that would match or exceed \$340.4 is $[1-(1- 2.77 \times 10^{-13})^{30752}] \approx 30752 \times 2.77 \times 10^{-13} \approx 0$ where 30752 is the total number of different filters we looked at in this run. This number is much much less than one, so it is improbable that our result was due to pure chance

**Figure 5 The out-of-sample 1-minute bar chart of all the LSQV Strategy buy and sell signals of the WFME64 filter with the LSQV Indicator.
4/30/18 to 5/4/18**



Figure 6 The out-of-sample 1-minute bar chart of all the LSQV Strategy buy and sell signals of the WFINP64 filter with the LSQV Indicator.
4/30/18 to 5/4/18



**Table 1 Walk Forward Out-Of-Sample Performance Summary
ES-Mini 1 min bars Least Squares Velocity Strategy with WFME64 Filter**

ES-1 min bars 10/08/2010 - 5/25/2018 using the below filter on each in-sample segment. The input values **N**, **vup**, and **vdn** are the values found from applying the filter to the in-sample section.

In-sample Section Filter: $t20m(p-rd)|pf<2|lr<3$ -std

Where:

osnp = Weekly Out-of-sample gross profit in \$

NOnp\$20 = Weekly Out-Of-Sample Net Profit in \$ = **osnp-ont*20**.

ont = The number of trades in the out-of-sample week.

oltt = The largest losing trade in the out-of-sample section in \$.

odd = The drawdown in the out-of-sample section in \$.

Equity = Running Sum of weekly out-of-sample gross profits \$

NetEq = running sum of the weekly out-of-sample net profits in \$

N = N the lookback period

vup, the threshold amount that velocity has to be greater than to issue a buy signal

vdn, the threshold amount that velocity has to be less than to issue a sell signal

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

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	oltt	odd	EQ	NetEq	N	vup	vdn
09/02/10	to	10/01/10	10/04/10	to	10/08/10	0	0	0	0	0	0	0	50	3	1.8
09/09/10	to	10/08/10	10/11/10	to	10/15/10	(925)	(965)	2	-575	-925	-925	-965	50	2.8	1.8
09/16/10	to	10/15/10	10/18/10	to	10/22/10	125	105	1	0	0	-800	-860	60	3.2	2
09/23/10	to	10/22/10	10/25/10	to	10/29/10	(525)	(545)	1	-525	-525	-1325	-1405	60	2.8	2
09/30/10	to	10/29/10	11/01/10	to	11/05/10	438	418	1	0	0	-887	-987	60	3	2.2
10/07/10	to	11/05/10	11/08/10	to	11/12/10	0	0	0	0	0	-887	-987	40	2.2	2.4
10/14/10	to	11/12/10	11/15/10	to	11/19/10	313	253	3	-400	-400	-574	-734	40	2.6	2.2
10/21/10	to	11/19/10	11/22/10	to	11/26/10	(388)	(488)	5	-475	-513	-962	-1222	60	0.2	2.8
10/28/10	to	11/26/10	11/29/10	to	12/03/10	475	435	2	0	0	-487	-787	70	1.8	3.2
11/04/10	to	12/03/10	12/06/10	to	12/10/10	(388)	(408)	1	-388	-388	-875	-1195	60	1.6	2.6
11/11/10	to	12/10/10	12/13/10	to	12/17/10	0	0	0	0	0	-875	-1195	50	1.8	2.4
11/18/10	to	12/17/10	12/20/10	to	12/24/10	0	0	0	0	0	-875	-1195	50	2.2	2.4
11/25/10	to	12/24/10	12/27/10	to	12/31/10	0	0	0	0	0	-875	-1195	40	2.4	1.4
12/02/10	to	12/31/10	01/03/11	to	01/07/11	(38)	(58)	1	-38	-38	-913	-1253	70	1.4	1.4
12/09/10	to	01/07/11	01/10/11	to	01/14/11	450	330	6	-113	-113	-463	-923	20	0.4	1.8
12/16/10	to	01/14/11	01/17/11	to	01/21/11	(288)	(348)	3	-375	-375	-751	-1271	30	0.8	1.8
12/23/10	to	01/21/11	01/24/11	to	01/28/11	375	255	6	-325	-325	-376	-1016	10	1.4	2.2
12/30/10	to	01/28/11	01/31/11	to	02/04/11	1100	1000	5	-150	-150	724	-16	40	0.6	2
01/06/11	to	02/04/11	02/07/11	to	02/11/11	(438)	(458)	1	-438	-438	286	-474	60	1.8	1.8
01/13/11	to	02/11/11	02/14/11	to	02/18/11	0	0	0	0	0	286	-474	60	1.6	1.8
01/20/11	to	02/18/11	02/21/11	to	02/25/11	1138	1078	3	0	0	1424	604	60	1.6	1.8
01/27/11	to	02/25/11	02/28/11	to	03/04/11	925	845	4	-250	-250	2349	1449	70	2.6	1.4
02/03/11	to	03/04/11	03/07/11	to	03/11/11	1213	1053	8	-75	-75	3562	2502	20	0.6	2.4
02/10/11	to	03/11/11	03/14/11	to	03/18/11	(1488)	(1588)	5	-900	-1488	2074	914	50	2.6	2
02/17/11	to	03/18/11	03/21/11	to	03/25/11	(25)	(45)	1	-25	-25	2049	869	60	3.4	3.2
02/24/11	to	03/25/11	03/28/11	to	04/01/11	0	0	0	0	0	2049	869	40	3.6	2.4
03/03/11	to	04/01/11	04/04/11	to	04/08/11	0	0	0	0	0	2049	869	40	3.6	2.4
03/10/11	to	04/08/11	04/11/11	to	04/15/11	0	0	0	0	0	2049	869	30	1.8	3.2
03/17/11	to	04/15/11	04/18/11	to	04/22/11	(113)	(133)	1	-113	-113	1936	736	10	1.8	2.8
03/24/11	to	04/22/11	04/25/11	to	04/29/11	0	0	0	0	0	1936	736	10	2	2.8
03/31/11	to	04/29/11	05/02/11	to	05/06/11	(63)	(163)	5	-138	-238	1873	573	10	2	2.6
04/07/11	to	05/06/11	05/09/11	to	05/13/11	288	208	4	-138	-138	2161	781	30	1.2	2.8
04/14/11	to	05/13/11	05/16/11	to	05/20/11	(275)	(335)	3	-413	-413	1886	446	10	1.4	3.4
04/21/11	to	05/20/11	05/23/11	to	05/27/11	(663)	(703)	2	-550	-663	1223	-257	10	2.6	1.8
04/28/11	to	05/27/11	05/30/11	to	06/03/11	50	(10)	3	-188	-188	1273	-267	10	1.4	3.4
05/05/11	to	06/03/11	06/06/11	to	06/10/11	0	0	0	0	0	1273	-267	70	2	2.8

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq	N	vup	vdn
05/12/11	to	06/10/11	06/13/11	to	06/17/11	800	760	2	0	0	2073	493	40	2	2
05/19/11	to	06/17/11	06/20/11	to	06/24/11	675	635	2	0	0	2748	1128	20	2.6	2.2
05/26/11	to	06/24/11	06/27/11	to	07/01/11	513	493	1	0	0	3261	1621	20	1.8	2.4
06/02/11	to	07/01/11	07/04/11	to	07/08/11	0	0	0	0	0	3261	1621	20	2	2.4
06/09/11	to	07/08/11	07/11/11	to	07/15/11	(1225)	(1285)	3	-588	-1225	2036	336	20	1.8	2.4
06/16/11	to	07/15/11	07/18/11	to	07/22/11	0	0	0	0	0	2036	336	10	3.6	3.2
06/23/11	to	07/22/11	07/25/11	to	07/29/11	(313)	(333)	1	-313	-313	1723	3	10	3.4	2.8
06/30/11	to	07/29/11	08/01/11	to	08/05/11	875	755	6	-1088	-1088	2598	758	60	3.4	3
07/07/11	to	08/05/11	08/08/11	to	08/12/11	3175	2855	16	-1175	-2075	5773	3613	20	3.4	2.8
07/14/11	to	08/12/11	08/15/11	to	08/19/11	250	130	6	-613	-1025	6023	3743	40	3.6	1.6
07/21/11	to	08/19/11	08/22/11	to	08/26/11	2150	2070	4	0	0	8173	5813	40	3.2	2.2
07/28/11	to	08/26/11	08/29/11	to	09/02/11	(13)	(113)	5	-663	-1038	8160	5700	40	3.2	1.8
08/04/11	to	09/02/11	09/05/11	to	09/09/11	975	895	4	-863	-863	9135	6595	40	3.4	1.6
08/11/11	to	09/09/11	09/12/11	to	09/16/11	(475)	(515)	2	-575	-575	8660	6080	50	3.6	2.4
08/18/11	to	09/16/11	09/19/11	to	09/23/11	(1750)	(1890)	7	-913	-1750	6910	4190	40	2	2.8
08/25/11	to	09/23/11	09/26/11	to	09/30/11	(1250)	(1290)	2	-650	-1250	5660	2900	70	2.6	3.6
09/01/11	to	09/30/11	10/03/11	to	10/07/11	888	828	3	-1025	-1025	6548	3728	50	3.2	3.4
09/08/11	to	10/07/11	10/10/11	to	10/14/11	913	873	2	0	0	7461	4601	50	3	3.4
09/15/11	to	10/14/11	10/17/11	to	10/21/11	125	85	2	-163	-163	7586	4686	50	3	3.4
09/22/11	to	10/21/11	10/24/11	to	10/28/11	1225	1185	2	0	0	8811	5871	50	3	3.4
09/29/11	to	10/28/11	10/31/11	to	11/04/11	1075	1035	2	0	0	9886	6906	50	3.4	3
10/06/11	to	11/04/11	11/07/11	to	11/11/11	563	503	3	-425	-425	10449	7409	60	3	2
10/13/11	to	11/11/11	11/14/11	to	11/18/11	1225	1185	2	0	0	11674	8594	60	3.6	2
10/20/11	to	11/18/11	11/21/11	to	11/25/11	225	165	3	-188	-188	11899	8759	50	2.2	2.4
10/27/11	to	11/25/11	11/28/11	to	12/02/11	313	193	6	-513	-550	12212	8952	30	2.2	0.6
11/03/11	to	12/02/11	12/05/11	to	12/09/11	275	195	4	-575	-875	12487	9147	70	2.6	2.4
11/10/11	to	12/09/11	12/12/11	to	12/16/11	(1888)	(1968)	4	-1125	-1913	10599	7179	60	2.2	3.6
11/17/11	to	12/16/11	12/19/11	to	12/23/11	488	468	1	0	0	11087	7647	50	3.4	3.6
11/24/11	to	12/23/11	12/26/11	to	12/30/11	0	0	0	0	0	11087	7647	40	3	3
12/01/11	to	12/30/11	01/02/12	to	01/06/12	(725)	(765)	2	-550	-725	10362	6882	60	2.8	2
12/08/11	to	01/06/12	01/09/12	to	01/13/12	(213)	(233)	1	-213	-213	10149	6649	40	3	2.4
12/15/11	to	01/13/12	01/16/12	to	01/20/12	488	468	1	0	0	10637	7117	30	1.2	2.4
12/22/11	to	01/20/12	01/23/12	to	01/27/12	463	443	1	0	0	11100	7560	20	1.6	1.6
12/29/11	to	01/27/12	01/30/12	to	02/03/12	(300)	(380)	4	-463	-663	10800	7180	70	1.2	2.8
01/05/12	to	02/03/12	02/06/12	to	02/10/12	500	460	2	0	0	11300	7640	30	0.8	2.2
01/12/12	to	02/10/12	02/13/12	to	02/17/12	875	815	3	0	0	12175	8455	30	0.8	2.2
01/19/12	to	02/17/12	02/20/12	to	02/24/12	0	0	0	0	0	12175	8455	30	2.4	1.4
01/26/12	to	02/24/12	02/27/12	to	03/02/12	(75)	(115)	2	-188	-188	12100	8340	20	2.4	1.4
02/02/12	to	03/02/12	03/05/12	to	03/09/12	(113)	(133)	1	-113	-113	11987	8207	30	2	1.4
02/09/12	to	03/09/12	03/12/12	to	03/16/12	325	305	1	0	0	12312	8512	30	1.8	1.8
02/16/12	to	03/16/12	03/19/12	to	03/23/12	0	0	0	0	0	12312	8512	10	2.6	1.8
02/23/12	to	03/23/12	03/26/12	to	03/30/12	(600)	(640)	2	-325	-600	11712	7872	10	2.6	1.8
03/01/12	to	03/30/12	04/02/12	to	04/06/12	200	180	1	0	0	11912	8052	40	2.4	1.8
03/08/12	to	04/06/12	04/09/12	to	04/13/12	1713	1653	3	0	0	13625	9705	10	1.8	1.6
03/15/12	to	04/13/12	04/16/12	to	04/20/12	(750)	(830)	4	-525	-925	12875	8875	20	1.6	2.4
03/22/12	to	04/20/12	04/23/12	to	04/27/12	(100)	(120)	1	-100	-100	12775	8755	10	2.6	2.4
03/29/12	to	04/27/12	04/30/12	to	05/04/12	300	260	2	0	0	13075	9015	30	2.6	1.6
04/05/12	to	05/04/12	05/07/12	to	05/11/12	200	160	2	-50	-50	13275	9175	30	1.4	2.6
04/12/12	to	05/11/12	05/14/12	to	05/18/12	1463	1383	4	-13	-13	14738	10558	10	3	1.8
04/19/12	to	05/18/12	05/21/12	to	05/25/12	0	0	0	0	0	14738	10558	20	3.2	2
04/26/12	to	05/25/12	05/28/12	to	06/01/12	963	903	3	0	0	15701	11461	70	2.6	3.2
05/03/12	to	06/01/12	06/04/12	to	06/08/12	100	80	1	0	0	15801	11541	10	2.8	2.4
05/10/12	to	06/08/12	06/11/12	to	06/15/12	(125)	(145)	1	-125	-125	15676	11396	30	2.4	2.2
05/17/12	to	06/15/12	06/18/12	to	06/22/12	950	930	1	0	0	16626	12326	30	3	2.2
05/24/12	to	06/22/12	06/25/12	to	06/29/12	463	383	4	-275	-300	17089	12709	50	2.4	2

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq	N	vup	vdn
05/31/12	to	06/29/12	07/02/12	to	07/06/12	25	5	1	0	0	17114	12714	50	2.2	2
06/07/12	to	07/06/12	07/09/12	to	07/13/12	0	0	0	0	0	17114	12714	30	2.2	2.8
06/14/12	to	07/13/12	07/16/12	to	07/20/12	0	0	0	0	0	17114	12714	20	2.4	3.2
06/21/12	to	07/20/12	07/23/12	to	07/27/12	1000	900	5	-163	-300	18114	13614	10	0.2	3.4
06/28/12	to	07/27/12	07/30/12	to	08/03/12	150	130	1	0	0	18264	13744	40	2.6	3.4
07/05/12	to	08/03/12	08/06/12	to	08/10/12	0	0	0	0	0	18264	13744	40	2.8	3.4
07/12/12	to	08/10/12	08/13/12	to	08/17/12	0	0	0	0	0	18264	13744	60	2.4	2.4
07/19/12	to	08/17/12	08/20/12	to	08/24/12	0	0	0	0	0	18264	13744	70	2.2	2.2
07/26/12	to	08/24/12	08/27/12	to	08/31/12	(363)	(383)	1	-363	-363	17901	13361	40	2.6	1.4
08/02/12	to	08/31/12	09/03/12	to	09/07/12	413	373	2	-200	-200	18314	13734	50	1.6	1.8
08/09/12	to	09/07/12	09/10/12	to	09/14/12	613	553	3	-88	-88	18927	14287	50	1.4	1.6
08/16/12	to	09/14/12	09/17/12	to	09/21/12	(463)	(483)	1	-463	-463	18464	13804	40	2.6	1.4
08/23/12	to	09/21/12	09/24/12	to	09/28/12	(125)	(145)	1	-125	-125	18339	13659	70	1.8	2
08/30/12	to	09/28/12	10/01/12	to	10/05/12	0	0	0	0	0	18339	13659	50	2.6	1.8
09/06/12	to	10/05/12	10/08/12	to	10/12/12	188	168	1	0	0	18527	13827	50	2.6	1.8
09/13/12	to	10/12/12	10/15/12	to	10/19/12	0	0	0	0	0	18527	13827	20	2.6	2.2
09/20/12	to	10/19/12	10/22/12	to	10/26/12	(250)	(350)	5	-313	-338	18277	13477	20	2.6	1.2
09/27/12	to	10/26/12	10/29/12	to	11/02/12	188	168	1	0	0	18465	13645	60	2.2	2.2
10/04/12	to	11/02/12	11/05/12	to	11/09/12	688	668	1	0	0	19153	14313	60	2.2	2.2
10/11/12	to	11/09/12	11/12/12	to	11/16/12	(288)	(348)	3	-600	-688	18865	13965	20	2.2	2.4
10/18/12	to	11/16/12	11/19/12	to	11/23/12	0	0	0	0	0	18865	13965	30	2	2
10/25/12	to	11/23/12	11/26/12	to	11/30/12	(175)	(215)	2	-275	-275	18690	13750	20	2.6	2
11/01/12	to	11/30/12	12/03/12	to	12/07/12	0	0	0	0	0	18690	13750	60	2.8	1.8
11/08/12	to	12/07/12	12/10/12	to	12/14/12	0	0	0	0	0	18690	13750	20	2.6	2.4
11/15/12	to	12/14/12	12/17/12	to	12/21/12	325	285	2	-100	-100	19015	14035	70	2	2.8
11/22/12	to	12/21/12	12/24/12	to	12/28/12	425	365	3	-188	-188	19440	14400	70	1.8	2.2
11/29/12	to	12/28/12	12/31/12	to	01/04/13	650	630	1	0	0	20090	15030	20	2	3
12/06/12	to	01/04/13	01/07/13	to	01/11/13	(113)	(133)	1	-113	-113	19977	14897	70	2.6	1.8
12/13/12	to	01/11/13	01/14/13	to	01/18/13	0	0	0	0	0	19977	14897	50	2.6	2
12/20/12	to	01/18/13	01/21/13	to	01/25/13	0	0	0	0	0	19977	14897	50	2.6	2
12/27/12	to	01/25/13	01/28/13	to	02/01/13	0	0	0	0	0	19977	14897	40	2.8	1.4
01/03/13	to	02/01/13	02/04/13	to	02/08/13	313	233	4	-325	-325	20290	15130	40	1	1.4
01/10/13	to	02/08/13	02/11/13	to	02/15/13	0	0	0	0	0	20290	15130	40	1.2	1.8
01/17/13	to	02/15/13	02/18/13	to	02/22/13	563	463	5	-125	-225	20853	15593	60	1.2	1.4
01/24/13	to	02/22/13	02/25/13	to	03/01/13	2200	2140	3	0	0	23053	17733	20	1.4	2
01/31/13	to	03/01/13	03/04/13	to	03/08/13	150	130	1	0	0	23203	17863	10	1.8	3
02/07/13	to	03/08/13	03/11/13	to	03/15/13	0	0	0	0	0	23203	17863	10	1.8	3
02/14/13	to	03/15/13	03/18/13	to	03/22/13	(213)	(253)	2	-188	-213	22990	17610	10	1.8	3
02/21/13	to	03/22/13	03/25/13	to	03/29/13	500	440	3	-50	-50	23490	18050	10	1.4	3
02/28/13	to	03/29/13	04/01/13	to	04/05/13	(738)	(798)	3	-625	-738	22752	17252	50	1.6	2.6
03/07/13	to	04/05/13	04/08/13	to	04/12/13	525	505	1	0	0	23277	17757	60	1.6	2.4
03/14/13	to	04/12/13	04/15/13	to	04/19/13	963	903	3	-13	-13	24240	18660	40	1.8	2.2
03/21/13	to	04/19/13	04/22/13	to	04/26/13	288	268	1	0	0	24528	18928	40	2	2.2
03/28/13	to	04/26/13	04/29/13	to	05/03/13	(38)	(58)	1	-38	-38	24490	18870	70	2	3.4
04/04/13	to	05/03/13	05/06/13	to	05/10/13	0	0	0	0	0	24490	18870	70	2	3.4
04/11/13	to	05/10/13	05/13/13	to	05/17/13	1113	1053	3	0	0	25603	19923	40	1.4	2.2
04/18/13	to	05/17/13	05/20/13	to	05/24/13	(25)	(145)	6	-513	-600	25578	19778	40	1.8	1.6
04/25/13	to	05/24/13	05/27/13	to	05/31/13	(800)	(900)	5	-600	-950	24778	18878	50	1.6	1.8
05/02/13	to	05/31/13	06/03/13	to	06/07/13	263	123	7	-325	-925	25041	19001	10	2.2	2.8
05/09/13	to	06/07/13	06/10/13	to	06/14/13	813	793	1	0	0	25854	19794	20	2.8	2
05/16/13	to	06/14/13	06/17/13	to	06/21/13	550	470	4	-700	-700	26404	20264	20	2.8	2
05/23/13	to	06/21/13	06/24/13	to	06/28/13	(400)	(460)	3	-288	-400	26004	19804	40	3	3.2
05/30/13	to	06/28/13	07/01/13	to	07/05/13	(263)	(283)	1	-263	-263	25741	19521	50	3	2.6
06/06/13	to	07/05/13	07/08/13	to	07/12/13	300	280	1	0	0	26041	19801	40	3.2	3.4
06/13/13	to	07/12/13	07/15/13	to	07/19/13	0	0	0	0	0	26041	19801	20	3	2.8

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq	N	vup	vdn
06/20/13	to	07/19/13	07/22/13	to	07/26/13	0	0	0	0	0	26041	19801	70	3.2	2.4
06/27/13	to	07/26/13	07/29/13	to	08/02/13	288	268	1	0	0	26329	20069	60	3	2
07/04/13	to	08/02/13	08/05/13	to	08/09/13	0	0	0	0	0	26329	20069	40	1.6	2.8
07/11/13	to	08/09/13	08/12/13	to	08/16/13	(275)	(375)	5	-238	-400	26054	19694	50	1	2.2
07/18/13	to	08/16/13	08/19/13	to	08/23/13	(375)	(435)	3	-650	-675	25679	19259	60	1.8	1.8
07/25/13	to	08/23/13	08/26/13	to	08/30/13	63	43	1	0	0	25742	19302	20	3.6	2.2
08/01/13	to	08/30/13	09/02/13	to	09/06/13	25	5	1	0	0	25767	19307	20	3.6	2.8
08/08/13	to	09/06/13	09/09/13	to	09/13/13	0	0	0	0	0	25767	19307	20	3.6	2.2
08/15/13	to	09/13/13	09/16/13	to	09/20/13	600	580	1	0	0	26367	19887	20	3.6	2.2
08/22/13	to	09/20/13	09/23/13	to	09/27/13	0	0	0	0	0	26367	19887	30	2.8	2.8
08/29/13	to	09/27/13	09/30/13	to	10/04/13	0	0	0	0	0	26367	19887	30	2.8	2.6
09/05/13	to	10/04/13	10/07/13	to	10/11/13	613	553	3	-50	-50	26980	20440	20	2.4	2
09/12/13	to	10/11/13	10/14/13	to	10/18/13	213	193	1	0	0	27193	20633	60	1.8	2.8
09/19/13	to	10/18/13	10/21/13	to	10/25/13	13	(7)	1	0	0	27206	20626	60	1.6	2.8
09/26/13	to	10/25/13	10/28/13	to	11/01/13	0	0	0	0	0	27206	20626	70	1.6	2.2
10/03/13	to	11/01/13	11/04/13	to	11/08/13	0	0	0	0	0	27206	20626	20	2.6	2.8
10/10/13	to	11/08/13	11/11/13	to	11/15/13	0	0	0	0	0	27206	20626	20	2.6	2.8
10/17/13	to	11/15/13	11/18/13	to	11/22/13	0	0	0	0	0	27206	20626	20	2.4	2.6
10/24/13	to	11/22/13	11/25/13	to	11/29/13	0	0	0	0	0	27206	20626	30	1.6	2.2
10/31/13	to	11/29/13	12/02/13	to	12/06/13	(1213)	(1253)	2	-750	-1213	25993	19373	30	2.6	2
11/07/13	to	12/06/13	12/09/13	to	12/13/13	0	0	0	0	0	25993	19373	40	1.6	2.8
11/14/13	to	12/13/13	12/16/13	to	12/20/13	775	715	3	-238	-238	26768	20088	40	2	2.8
11/21/13	to	12/20/13	12/23/13	to	12/27/13	0	0	0	0	0	26768	20088	40	3	2.8
11/28/13	to	12/27/13	12/30/13	to	01/03/14	338	318	1	0	0	27106	20406	40	3	2.8
12/05/13	to	01/03/14	01/06/14	to	01/10/14	(288)	(368)	4	-313	-363	26818	20038	10	2	1.6
12/12/13	to	01/10/14	01/13/14	to	01/17/14	1225	1125	5	-138	-263	28043	21163	10	2	1.6
12/19/13	to	01/17/14	01/20/14	to	01/24/14	1175	1115	3	-88	-88	29218	22278	40	2.6	1.2
12/26/13	to	01/24/14	01/27/14	to	01/31/14	(113)	(193)	4	-475	-613	29105	22085	70	1.8	3.6
01/02/14	to	01/31/14	02/03/14	to	02/07/14	2138	2058	4	-63	-63	31243	24143	60	2.2	3.6
01/09/14	to	02/07/14	02/10/14	to	02/14/14	0	0	0	0	0	31243	24143	30	2.8	2.2
01/16/14	to	02/14/14	02/17/14	to	02/21/14	0	0	0	0	0	31243	24143	30	2.8	2.2
01/23/14	to	02/21/14	02/24/14	to	02/28/14	(175)	(195)	1	-175	-175	31068	23948	30	2.8	2
01/30/14	to	02/28/14	03/03/14	to	03/07/14	25	(35)	3	-300	-300	31093	23913	40	2.4	2.2
02/06/14	to	03/07/14	03/10/14	to	03/14/14	(475)	(575)	5	-575	-825	30618	23338	10	1.2	3.2
02/13/14	to	03/14/14	03/17/14	to	03/21/14	663	623	2	0	0	31281	23961	10	2.2	3.4
02/20/14	to	03/21/14	03/24/14	to	03/28/14	438	418	1	0	0	31719	24379	20	3.2	2.6
02/27/14	to	03/28/14	03/31/14	to	04/04/14	0	0	0	0	0	31719	24379	10	3	3.6
03/06/14	to	04/04/14	04/07/14	to	04/11/14	(900)	(920)	1	-900	-900	30819	23459	10	3	3.6
03/13/14	to	04/11/14	04/14/14	to	04/18/14	(1150)	(1210)	3	-600	-1150	29669	22249	50	2.6	3
03/20/14	to	04/18/14	04/21/14	to	04/25/14	0	0	0	0	0	29669	22249	50	2.8	3.2
03/27/14	to	04/25/14	04/28/14	to	05/02/14	(750)	(790)	2	-725	-750	28919	21459	30	2.6	2.4
04/03/14	to	05/02/14	05/05/14	to	05/09/14	0	0	0	0	0	28919	21459	60	2.6	2.8
04/10/14	to	05/09/14	05/12/14	to	05/16/14	375	335	2	0	0	29294	21794	60	2.4	2.8
04/17/14	to	05/16/14	05/19/14	to	05/23/14	238	218	1	0	0	29532	22012	60	2	3
04/24/14	to	05/23/14	05/26/14	to	05/30/14	163	143	1	0	0	29695	22155	60	2	3.6
05/01/14	to	05/30/14	06/02/14	to	06/06/14	0	0	0	0	0	29695	22155	30	2.2	3.4
05/08/14	to	06/06/14	06/09/14	to	06/13/14	88	68	1	0	0	29783	22223	30	1.6	2.2
05/15/14	to	06/13/14	06/16/14	to	06/20/14	(175)	(195)	1	-175	-175	29608	22028	50	3.2	1.4
05/22/14	to	06/20/14	06/23/14	to	06/27/14	(388)	(448)	3	-525	-525	29220	21580	50	1.4	1.4
05/29/14	to	06/27/14	06/30/14	to	07/04/14	338	278	3	-188	-188	29558	21858	70	0.4	1.4
06/05/14	to	07/04/14	07/07/14	to	07/11/14	(238)	(278)	2	-463	-463	29320	21580	40	1.4	2.2
06/12/14	to	07/11/14	07/14/14	to	07/18/14	(13)	(33)	1	-13	-13	29307	21547	40	1.4	3.4
06/19/14	to	07/18/14	07/21/14	to	07/25/14	0	0	0	0	0	29307	21547	20	2.2	2.2
06/26/14	to	07/25/14	07/28/14	to	08/01/14	(1038)	(1178)	7	-663	-1238	28269	20369	20	1.4	2.4
07/03/14	to	08/01/14	08/04/14	to	08/08/14	438	278	8	-775	-1025	28707	20647	20	1.2	2.6

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq	N	vup	vdn
07/10/14	to	08/08/14	08/11/14	to	08/15/14	(38)	(58)	1	-38	-38	28669	20589	30	2.6	2.2
07/17/14	to	08/15/14	08/18/14	to	08/22/14	0	0	0	0	0	28669	20589	30	2.8	2.4
07/24/14	to	08/22/14	08/25/14	to	08/29/14	0	0	0	0	0	28669	20589	30	2.8	2.4
07/31/14	to	08/29/14	09/01/14	to	09/05/14	0	0	0	0	0	28669	20589	30	3	2.2
08/07/14	to	09/05/14	09/08/14	to	09/12/14	175	155	1	0	0	28844	20744	60	3	1.8
08/14/14	to	09/12/14	09/15/14	to	09/19/14	(25)	(45)	1	-25	-25	28819	20699	60	3	1.6
08/21/14	to	09/19/14	09/22/14	to	09/26/14	1313	1273	2	0	0	30132	21972	60	2.6	1.6
08/28/14	to	09/26/14	09/29/14	to	10/03/14	(688)	(808)	6	-688	-1488	29444	21164	20	1.4	2.4
09/04/14	to	10/03/14	10/06/14	to	10/10/14	188	(112)	15	-1163	-1550	29632	21052	10	2.6	2.6
09/11/14	to	10/10/14	10/13/14	to	10/17/14	2550	2430	6	-225	-225	32182	23482	70	2.4	3.4
09/18/14	to	10/17/14	10/20/14	to	10/24/14	1188	1148	2	0	0	33370	24630	40	2.8	3.4
09/25/14	to	10/24/14	10/27/14	to	10/31/14	(1738)	(1818)	4	-1000	-1738	31632	22812	20	3.6	1
10/02/14	to	10/31/14	11/03/14	to	11/07/14	0	0	0	0	0	31632	22812	30	3	3
10/09/14	to	11/07/14	11/10/14	to	11/14/14	0	0	0	0	0	31632	22812	40	3.2	3.2
10/16/14	to	11/14/14	11/17/14	to	11/21/14	0	0	0	0	0	31632	22812	20	2.4	3.2
10/23/14	to	11/21/14	11/24/14	to	11/28/14	0	0	0	0	0	31632	22812	60	1.4	2.8
10/30/14	to	11/28/14	12/01/14	to	12/05/14	(25)	(45)	1	-25	-25	31607	22767	50	1.8	2
11/06/14	to	12/05/14	12/08/14	to	12/12/14	1688	1548	7	-463	-463	33295	24315	50	1.8	1.8
11/13/14	to	12/12/14	12/15/14	to	12/19/14	1488	1308	9	-563	-588	34783	25623	50	1.8	2.2
11/20/14	to	12/19/14	12/22/14	to	12/26/14	0	0	0	0	0	34783	25623	30	3.6	3
11/27/14	to	12/26/14	12/29/14	to	01/02/15	75	55	1	0	0	34858	25678	30	3.6	3
12/04/14	to	01/02/15	01/05/15	to	01/09/15	2038	1958	4	0	0	36896	27636	60	3	3
12/11/14	to	01/09/15	01/12/15	to	01/16/15	(538)	(678)	7	-1638	-1963	36358	26958	60	2.6	2.6
12/18/14	to	01/16/15	01/19/15	to	01/23/15	288	208	4	-450	-813	36646	27166	70	2.4	1.2
12/25/14	to	01/23/15	01/26/15	to	01/30/15	1588	1528	3	0	0	38234	28694	50	3.4	2.8
01/01/15	to	01/30/15	02/02/15	to	02/06/15	(1163)	(1263)	5	-1925	-1963	37071	27431	40	3.6	3
01/08/15	to	02/06/15	02/09/15	to	02/13/15	(163)	(203)	2	-513	-513	36908	27228	70	2.4	1.2
01/15/15	to	02/13/15	02/16/15	to	02/20/15	(1225)	(1245)	1	-1225	-1225	35683	25983	70	3.4	2
01/22/15	to	02/20/15	02/23/15	to	02/27/15	0	0	0	0	0	35683	25983	30	2.8	2.8
01/29/15	to	02/27/15	03/02/15	to	03/06/15	(300)	(320)	1	-300	-300	35383	25663	40	2.6	3.6
02/05/15	to	03/06/15	03/09/15	to	03/13/15	200	140	3	0	0	35583	25803	20	2.6	2
02/12/15	to	03/13/15	03/16/15	to	03/20/15	1113	1053	3	0	0	36696	26856	70	3.2	3.4
02/19/15	to	03/20/15	03/23/15	to	03/27/15	825	805	1	0	0	37521	27661	50	3	2.4
02/26/15	to	03/27/15	03/30/15	to	04/03/15	125	65	3	-488	-488	37646	27726	60	2.6	2.2
03/05/15	to	04/03/15	04/06/15	to	04/10/15	75	35	2	-200	-200	37721	27761	60	2	2.2
03/12/15	to	04/10/15	04/13/15	to	04/17/15	(363)	(403)	2	-613	-613	37358	27358	40	3.4	2.2
03/19/15	to	04/17/15	04/20/15	to	04/24/15	25	5	1	0	0	37383	27363	50	2.4	2
03/26/15	to	04/24/15	04/27/15	to	05/01/15	63	3	3	-963	-963	37446	27366	60	3	2
04/02/15	to	05/01/15	05/04/15	to	05/08/15	(1013)	(1093)	4	-500	-1175	36433	26273	50	1.8	2.8
04/09/15	to	05/08/15	05/11/15	to	05/15/15	(13)	(93)	4	-488	-488	36420	26180	20	1.2	3.6
04/16/15	to	05/15/15	05/18/15	to	05/22/15	0	0	0	0	0	36420	26180	10	3.6	3
04/23/15	to	05/22/15	05/25/15	to	05/29/15	413	393	1	0	0	36833	26573	60	3.4	2.6
04/30/15	to	05/29/15	06/01/15	to	06/05/15	(713)	(753)	2	-475	-713	36120	25820	20	3	2.6
05/07/15	to	06/05/15	06/08/15	to	06/12/15	(313)	(333)	1	-313	-313	35807	25487	30	2.6	2.2
05/14/15	to	06/12/15	06/15/15	to	06/19/15	(475)	(495)	1	-475	-475	35332	24992	40	3.6	2.2
05/21/15	to	06/19/15	06/22/15	to	06/26/15	(88)	(108)	1	-88	-88	35244	24884	60	2	2
05/28/15	to	06/26/15	06/29/15	to	07/03/15	700	640	3	-613	-750	35944	25524	70	2.2	1.8
06/04/15	to	07/03/15	07/06/15	to	07/10/15	(50)	(110)	3	-975	-975	35894	25414	20	3.6	2.2
06/11/15	to	07/10/15	07/13/15	to	07/17/15	225	205	1	0	0	36119	25619	40	3.4	3.4
06/18/15	to	07/17/15	07/20/15	to	07/24/15	0	0	0	0	0	36119	25619	20	3.2	2.2
06/25/15	to	07/24/15	07/27/15	to	07/31/15	0	0	0	0	0	36119	25619	20	3.2	2.2
07/02/15	to	07/31/15	08/03/15	to	08/07/15	75	55	1	0	0	36194	25674	30	1.8	2.4
07/09/15	to	08/07/15	08/10/15	to	08/14/15	1425	1345	4	-150	-150	37619	27019	70	2	3.2
07/16/15	to	08/14/15	08/17/15	to	08/21/15	2238	2098	7	-738	-1513	39857	29117	60	2.2	2.6
07/23/15	to	08/21/15	08/24/15	to	08/28/15	7038	6818	11	-1225	-2088	46895	35935	30	3.4	3.6

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq	N	vup	vdn
07/30/15	to	08/28/15	08/31/15	to	09/04/15	75	(65)	7	-600	-1088	46970	35870	70	1.4	3
08/06/15	to	09/04/15	09/07/15	to	09/11/15	(1088)	(1168)	4	-1950	-1950	45882	34702	40	3.2	3
08/13/15	to	09/11/15	09/14/15	to	09/18/15	(400)	(480)	4	-1025	-1113	45482	34222	40	3.4	2.8
08/20/15	to	09/18/15	09/21/15	to	09/25/15	(1075)	(1195)	6	-875	-1425	44407	33027	50	2.6	3
08/27/15	to	09/25/15	09/28/15	to	10/02/15	3225	3105	6	-600	-600	47632	36132	60	2.2	2.6
09/03/15	to	10/02/15	10/05/15	to	10/09/15	(550)	(630)	4	-625	-1250	47082	35502	60	2.2	2.6
09/10/15	to	10/09/15	10/12/15	to	10/16/15	(63)	(143)	4	-725	-1225	47019	35359	30	1	2.8
09/17/15	to	10/16/15	10/19/15	to	10/23/15	13	(87)	5	-750	-775	47032	35272	30	1.4	3.4
09/24/15	to	10/23/15	10/26/15	to	10/30/15	(213)	(253)	2	-713	-713	46819	35019	50	2.8	3
10/01/15	to	10/30/15	11/02/15	to	11/06/15	(950)	(990)	2	-650	-950	45869	34029	50	3	2.8
10/08/15	to	11/06/15	11/09/15	to	11/13/15	225	185	2	-113	-113	46094	34214	30	2.4	2.6
10/15/15	to	11/13/15	11/16/15	to	11/20/15	(388)	(428)	2	-475	-475	45706	33786	30	2.6	2.8
10/22/15	to	11/20/15	11/23/15	to	11/27/15	375	355	1	0	0	46081	34141	20	2.4	3
10/29/15	to	11/27/15	11/30/15	to	12/04/15	1438	1398	2	0	0	47519	35539	20	2.4	3
11/05/15	to	12/04/15	12/07/15	to	12/11/15	(938)	(1038)	5	-1088	-2075	46581	34501	70	2.6	2.8
11/12/15	to	12/11/15	12/14/15	to	12/18/15	1425	1365	3	-238	-238	48006	35866	40	2.8	3.2
11/19/15	to	12/18/15	12/21/15	to	12/25/15	0	0	0	0	0	48006	35866	40	3.4	3
11/26/15	to	12/25/15	12/28/15	to	01/01/16	188	168	1	0	0	48194	36034	40	3.4	3.2
12/03/15	to	01/01/16	01/04/16	to	01/08/16	(3250)	(3410)	8	-1863	-3513	44944	32624	50	2.4	3.2
12/10/15	to	01/08/16	01/11/16	to	01/15/16	725	625	5	-163	-250	45669	33249	70	2.4	2.6
12/17/15	to	01/15/16	01/18/16	to	01/22/16	1250	1110	7	-1038	-1450	46919	34359	70	2	2.6
12/24/15	to	01/22/16	01/25/16	to	01/29/16	(1438)	(1578)	7	-1263	-3125	45481	32781	70	2.2	3.2
12/31/15	to	01/29/16	02/01/16	to	02/05/16	(725)	(865)	7	-1175	-1813	44756	31916	60	3.2	2.8
01/07/16	to	02/05/16	02/08/16	to	02/12/16	613	493	6	-600	-600	45369	32409	20	2.6	3.6
01/14/16	to	02/12/16	02/15/16	to	02/19/16	1450	1370	4	-250	-250	46819	33779	70	1	3
01/21/16	to	02/19/16	02/22/16	to	02/26/16	1575	1475	5	-550	-550	48394	35254	20	1.4	3.4
01/28/16	to	02/26/16	02/29/16	to	03/04/16	1050	1030	1	0	0	49444	36284	30	3	3.6
02/04/16	to	03/04/16	03/07/16	to	03/11/16	0	0	0	0	0	49444	36284	30	3.4	3.4
02/11/16	to	03/11/16	03/14/16	to	03/18/16	(463)	(483)	1	-463	-463	48981	35801	50	3.6	3.2
02/18/16	to	03/18/16	03/21/16	to	03/25/16	0	0	0	0	0	48981	35801	40	2.6	3.2
02/25/16	to	03/25/16	03/28/16	to	04/01/16	1150	1090	3	-238	-238	50131	36891	40	2.6	3.4
03/03/16	to	04/01/16	04/04/16	to	04/08/16	0	0	0	0	0	50131	36891	20	3.6	3
03/10/16	to	04/08/16	04/11/16	to	04/15/16	(88)	(148)	3	-863	-863	50043	36743	70	2.2	3.6
03/17/16	to	04/15/16	04/18/16	to	04/22/16	(13)	(53)	2	-488	-488	50030	36690	50	2.2	2
03/24/16	to	04/22/16	04/25/16	to	04/29/16	(263)	(323)	3	-250	-263	49767	36367	40	2	2
03/31/16	to	04/29/16	05/02/16	to	05/06/16	(25)	(45)	1	-25	-25	49742	36322	40	3.4	3.4
04/07/16	to	05/06/16	05/09/16	to	05/13/16	(800)	(900)	5	-775	-1163	48942	35422	20	0.6	3.2
04/14/16	to	05/13/16	05/16/16	to	05/20/16	13	(187)	10	-600	-913	48955	35235	10	0.8	3.4
04/21/16	to	05/20/16	05/23/16	to	05/27/16	288	188	5	-313	-313	49243	35423	20	0.6	3
04/28/16	to	05/27/16	05/30/16	to	06/03/16	663	603	3	0	0	49906	36026	20	1.4	3.2
05/05/16	to	06/03/16	06/06/16	to	06/10/16	213	133	4	-13	-13	50119	36159	50	1.2	2.2
05/12/16	to	06/10/16	06/13/16	to	06/17/16	675	615	3	-225	-225	50794	36774	10	2.2	3.2
05/19/16	to	06/17/16	06/20/16	to	06/24/16	(1588)	(1648)	3	-1200	-1588	49206	35126	30	2	3
05/26/16	to	06/24/16	06/27/16	to	07/01/16	2175	2055	6	-163	-163	51381	37181	60	1.8	2
06/02/16	to	07/01/16	07/04/16	to	07/08/16	1225	1165	3	-13	-13	52606	38346	60	2.4	3.6
06/09/16	to	07/08/16	07/11/16	to	07/15/16	50	10	2	-113	-113	52656	38356	50	2.4	2
06/16/16	to	07/15/16	07/18/16	to	07/22/16	0	0	0	0	0	52656	38356	50	2.4	2
06/23/16	to	07/22/16	07/25/16	to	07/29/16	(338)	(358)	1	-338	-338	52318	37998	40	2.8	2.2
06/30/16	to	07/29/16	08/01/16	to	08/05/16	138	118	1	0	0	52456	38116	50	2.2	2.8
07/07/16	to	08/05/16	08/08/16	to	08/12/16	(188)	(288)	5	-263	-400	52268	37828	30	0.2	2.8
07/14/16	to	08/12/16	08/15/16	to	08/19/16	0	0	0	0	0	52268	37828	20	2.2	3.2
07/21/16	to	08/19/16	08/22/16	to	08/26/16	(1500)	(1580)	4	-1163	-1500	50768	36248	20	2.2	3.2
07/28/16	to	08/26/16	08/29/16	to	09/02/16	(263)	(303)	2	-413	-413	50505	35945	20	1.8	2.4
08/04/16	to	09/02/16	09/05/16	to	09/09/16	1825	1785	2	0	0	52330	37730	50	0.8	2
08/11/16	to	09/09/16	09/12/16	to	09/16/16	1513	1413	5	-350	-475	53843	39143	20	2	3.6

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq	N	vup	vdn
08/18/16	to	09/16/16	09/19/16	to	09/23/16	475	455	1	0	0	54318	39598	20	3.2	3.6
08/25/16	to	09/23/16	09/26/16	to	09/30/16	363	283	4	-200	-200	54681	39881	10	2.4	3.4
09/01/16	to	09/30/16	10/03/16	to	10/07/16	0	0	0	0	0	54681	39881	20	3.6	3.6
09/08/16	to	10/07/16	10/10/16	to	10/14/16	0	0	0	0	0	54681	39881	20	3.6	3.6
09/15/16	to	10/14/16	10/17/16	to	10/21/16	(313)	(333)	1	-313	-313	54368	39548	30	3	2.8
09/22/16	to	10/21/16	10/24/16	to	10/28/16	313	293	1	0	0	54681	39841	10	3.6	3
09/29/16	to	10/28/16	10/31/16	to	11/04/16	1163	1083	4	0	0	55844	40924	30	2.6	1.4
10/06/16	to	11/04/16	11/07/16	to	11/11/16	(525)	(605)	4	-550	-775	55319	40319	10	3.6	3.6
10/13/16	to	11/11/16	11/14/16	to	11/18/16	0	0	0	0	0	55319	40319	20	3.4	3.6
10/20/16	to	11/18/16	11/21/16	to	11/25/16	0	0	0	0	0	55319	40319	70	3.6	2.6
10/27/16	to	11/25/16	11/28/16	to	12/02/16	0	0	0	0	0	55319	40319	70	3.6	2.6
11/03/16	to	12/02/16	12/05/16	to	12/09/16	(100)	(120)	1	-100	-100	55219	40199	60	3	2
11/10/16	to	12/09/16	12/12/16	to	12/16/16	(275)	(355)	4	-325	-525	54944	39844	40	2.4	2.8
11/17/16	to	12/16/16	12/19/16	to	12/23/16	0	0	0	0	0	54944	39844	50	3.4	2.8
11/24/16	to	12/23/16	12/26/16	to	12/30/16	0	0	0	0	0	54944	39844	50	3.4	2.8
12/01/16	to	12/30/16	01/02/17	to	01/06/17	75	55	1	0	0	55019	39899	50	3.4	2.8
12/08/16	to	01/06/17	01/09/17	to	01/13/17	(450)	(470)	1	-450	-450	54569	39429	50	2.6	3
12/15/16	to	01/13/17	01/16/17	to	01/20/17	0	0	0	0	0	54569	39429	30	2.4	3.4
12/22/16	to	01/20/17	01/23/17	to	01/27/17	0	0	0	0	0	54569	39429	30	2.4	3.4
12/29/16	to	01/27/17	01/30/17	to	02/03/17	0	0	0	0	0	54569	39429	30	2.4	3.4
01/05/17	to	02/03/17	02/06/17	to	02/10/17	0	0	0	0	0	54569	39429	20	2.2	3.4
01/12/17	to	02/10/17	02/13/17	to	02/17/17	213	193	1	0	0	54782	39622	50	1.6	3.2
01/19/17	to	02/17/17	02/20/17	to	02/24/17	175	155	1	0	0	54957	39777	50	2.2	2.2
01/26/17	to	02/24/17	02/27/17	to	03/03/17	475	455	1	0	0	55432	40232	70	1.2	2.2
02/02/17	to	03/03/17	03/06/17	to	03/10/17	(75)	(95)	1	-75	-75	55357	40137	40	2.2	2
02/09/17	to	03/10/17	03/13/17	to	03/17/17	213	173	2	0	0	55570	40310	20	1.4	3.2
02/16/17	to	03/17/17	03/20/17	to	03/24/17	(625)	(705)	4	-525	-625	54945	39605	20	1.4	3.2
02/23/17	to	03/24/17	03/27/17	to	03/31/17	(213)	(253)	2	-563	-563	54732	39352	50	1.6	3
03/02/17	to	03/31/17	04/03/17	to	04/07/17	(825)	(865)	2	-950	-950	53907	38487	60	2.2	3
03/09/17	to	04/07/17	04/10/17	to	04/14/17	(938)	(998)	3	-863	-938	52969	37489	50	1.6	3
03/16/17	to	04/14/17	04/17/17	to	04/21/17	0	0	0	0	0	52969	37489	20	3.2	2.2
03/23/17	to	04/21/17	04/24/17	to	04/28/17	0	0	0	0	0	52969	37489	20	3	2.4
03/30/17	to	04/28/17	05/01/17	to	05/05/17	0	0	0	0	0	52969	37489	20	2.4	2
04/06/17	to	05/05/17	05/08/17	to	05/12/17	0	0	0	0	0	52969	37489	10	2.6	3
04/13/17	to	05/12/17	05/15/17	to	05/19/17	800	740	3	-25	-25	53769	38229	10	2.6	2.6
04/20/17	to	05/19/17	05/22/17	to	05/26/17	400	300	5	-13	-13	54169	38529	50	0.4	2
04/27/17	to	05/26/17	05/29/17	to	06/02/17	1450	1370	4	0	0	55619	39899	10	0.2	3
05/04/17	to	06/02/17	06/05/17	to	06/09/17	(50)	(90)	2	-213	-213	55569	39809	30	2.2	2.2
05/11/17	to	06/09/17	06/12/17	to	06/16/17	325	305	1	0	0	55894	40114	20	1.4	3.6
05/18/17	to	06/16/17	06/19/17	to	06/23/17	(13)	(53)	2	-188	-188	55881	40061	20	1.6	2.6
05/25/17	to	06/23/17	06/26/17	to	06/30/17	(100)	(180)	4	-550	-550	55781	39881	60	1.2	3.6
06/01/17	to	06/30/17	07/03/17	to	07/07/17	213	193	1	0	0	55994	40074	30	2.4	1.6
06/08/17	to	07/07/17	07/10/17	to	07/14/17	13	(27)	2	-25	-25	56007	40047	70	1	2.2
06/15/17	to	07/14/17	07/17/17	to	07/21/17	0	0	0	0	0	56007	40047	10	2	3.2
06/22/17	to	07/21/17	07/24/17	to	07/28/17	(500)	(520)	1	-500	-500	55507	39527	20	2	2.8
06/29/17	to	07/28/17	07/31/17	to	08/04/17	(400)	(460)	3	-338	-450	55107	39067	20	2.2	1.8
07/06/17	to	08/04/17	08/07/17	to	08/11/17	1050	1030	1	0	0	56157	40097	70	1.6	1.8
07/13/17	to	08/11/17	08/14/17	to	08/18/17	1063	1003	3	-263	-263	57220	41100	40	1.8	2.2
07/20/17	to	08/18/17	08/21/17	to	08/25/17	38	(42)	4	-375	-675	57258	41058	60	1	3.6
07/27/17	to	08/25/17	08/28/17	to	09/01/17	425	365	3	-163	-163	57683	41423	10	1.6	2.2
08/03/17	to	09/01/17	09/04/17	to	09/08/17	0	0	0	0	0	57683	41423	70	1.8	3.4
08/10/17	to	09/08/17	09/11/17	to	09/15/17	313	293	1	0	0	57996	41716	70	1.6	3.4
08/17/17	to	09/15/17	09/18/17	to	09/22/17	(125)	(145)	1	-125	-125	57871	41571	70	1.6	2.8
08/24/17	to	09/22/17	09/25/17	to	09/29/17	(163)	(183)	1	-163	-163	57708	41388	20	1.2	3.4
08/31/17	to	09/29/17	10/02/17	to	10/06/17	613	573	2	0	0	58321	41961	50	1.2	2.8

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq	N	vup	vdn
09/07/17	to	10/06/17	10/09/17	to	10/13/17	(38)	(58)	1	-38	-38	58283	41903	40	1.2	2.2
09/14/17	to	10/13/17	10/16/17	to	10/20/17	(400)	(460)	3	-638	-675	57883	41443	50	1.2	2.6
09/21/17	to	10/20/17	10/23/17	to	10/27/17	375	335	2	-225	-225	58258	41778	60	1.4	3
09/28/17	to	10/27/17	10/30/17	to	11/03/17	(175)	(255)	4	-250	-438	58083	41523	30	1.6	1.4
10/05/17	to	11/03/17	11/06/17	to	11/10/17	63	43	1	0	0	58146	41566	30	1	2.2
10/12/17	to	11/10/17	11/13/17	to	11/17/17	175	75	5	-500	-500	58321	41641	30	1	2
10/19/17	to	11/17/17	11/20/17	to	11/24/17	0	0	0	0	0	58321	41641	30	1.8	3.2
10/26/17	to	11/24/17	11/27/17	to	12/01/17	475	415	3	-450	-450	58796	42056	30	1.8	3.2
11/02/17	to	12/01/17	12/04/17	to	12/08/17	(1138)	(1158)	1	-1138	-1138	57658	40898	40	3.2	3.6
11/09/17	to	12/08/17	12/11/17	to	12/15/17	0	0	0	0	0	57658	40898	30	2.6	2.4
11/16/17	to	12/15/17	12/18/17	to	12/22/17	(75)	(95)	1	-75	-75	57583	40803	60	3	1.6
11/23/17	to	12/22/17	12/25/17	to	12/29/17	0	0	0	0	0	57583	40803	60	3	1.6
11/30/17	to	12/29/17	01/01/18	to	01/05/18	288	268	1	0	0	57871	41071	60	3	1.6
12/07/17	to	01/05/18	01/08/18	to	01/12/18	(388)	(408)	1	-388	-388	57483	40663	60	3.4	1.2
12/14/17	to	01/12/18	01/15/18	to	01/19/18	238	38	10	-588	-1313	57721	40701	10	2.2	1.8
12/21/17	to	01/19/18	01/22/18	to	01/26/18	888	788	5	-775	-888	58609	41489	70	1.8	2.2
12/28/17	to	01/26/18	01/29/18	to	02/02/18	(4513)	(4693)	9	-1625	-4513	54096	36796	30	1.8	3
01/04/18	to	02/02/18	02/05/18	to	02/09/18	1513	1133	19	-1663	-2500	55609	37929	50	2.2	3.4
01/11/18	to	02/09/18	02/12/18	to	02/16/18	(4700)	(4860)	8	-1925	-4700	50909	33069	40	3.6	3.2
01/18/18	to	02/16/18	02/19/18	to	02/23/18	1013	793	11	-1288	-1288	51922	33862	40	2.6	0.8
01/25/18	to	02/23/18	02/26/18	to	03/02/18	2688	2468	11	-875	-1663	54610	36330	20	3.6	3
02/01/18	to	03/02/18	03/05/18	to	03/09/18	863	783	4	-725	-1013	55473	37113	20	3.2	2.8
02/08/18	to	03/09/18	03/12/18	to	03/16/18	(4213)	(4313)	5	-1638	-4213	51260	32800	60	1.4	3.6
02/15/18	to	03/16/18	03/19/18	to	03/23/18	2600	2480	6	-1350	-1350	53860	35280	70	2.8	3.4
02/22/18	to	03/23/18	03/26/18	to	03/30/18	(325)	(505)	9	-1600	-2788	53535	34775	70	2.6	2.6
03/01/18	to	03/30/18	04/02/18	to	04/06/18	6800	6680	6	-763	-763	60335	41455	70	3	2.6
03/08/18	to	04/06/18	04/09/18	to	04/13/18	438	338	5	-463	-750	60773	41793	40	3.6	3.4
03/15/18	to	04/13/18	04/16/18	to	04/20/18	1038	958	4	0	0	61811	42751	70	2.8	2.4
03/22/18	to	04/20/18	04/23/18	to	04/27/18	63	3	3	-1275	-1275	61874	42754	40	3.6	2.6
03/29/18	to	04/27/18	04/30/18	to	05/04/18	613	513	5	-1188	-1300	62487	43267	50	3	3.6
04/05/18	to	05/04/18	05/07/18	to	05/11/18	425	365	3	-438	-438	62912	43632	40	2.6	3.4
04/12/18	to	05/11/18	05/14/18	to	05/18/18	(1050)	(1130)	4	-475	-1050	61862	42502	70	1.6	3
04/19/18	to	05/18/18	05/21/18	to	05/25/18	25	5	1	0	0	61887	42507	70	2.6	3.6

**Table 2 Walk Forward Out-Of-Sample Performance Summary
ES-Mini 1 min bars Least Squares Velocity Strategy with WFINP64 Filter**

ES-1 min bars 10/8/2010 - 5/25/2018 using the below filter on each in-sample segment.

In-sample Section Filter: 70|2|2.8|pf<5.5|lr<3

Where:

osnp = Weekly Out-of-sample gross profit in \$

NOnp\$20 = Weekly Out-Of-Sample Net Profit in \$ = **osnp-ont*20**.

ont = The number of trades in the out-of-sample week.

ollt = The largest losing trade in the out-of-sample section in \$.

odd = The drawdown in the out-of-sample section in \$.

Equity = Running Sum of weekly out-of-sample gross profits \$

NetEq = running sum of the weekly out-of-sample net profits in \$

N = N the lookback period

vup, the threshold amount that velocity has to be greater than to issue a buy signal

vdn, the threshold amount that velocity has to be less than to issue a sell signal

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

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq
09/02/10	to	10/01/10	10/04/10	to	10/08/10	400	380	1	0	0	400	380
09/09/10	to	10/08/10	10/11/10	to	10/15/10	0	0	0	0	0	400	380
09/16/10	to	10/15/10	10/18/10	to	10/22/10	438	398	2	0	0	838	778
09/23/10	to	10/22/10	10/25/10	to	10/29/10	(438)	(458)	1	-438	-438	400	320
09/30/10	to	10/29/10	11/01/10	to	11/05/10	(113)	(173)	3	-588	-588	287	147
10/07/10	to	11/05/10	11/08/10	to	11/12/10	0	0	0	0	0	287	147
10/14/10	to	11/12/10	11/15/10	to	11/19/10	225	205	1	0	0	512	352
10/21/10	to	11/19/10	11/22/10	to	11/26/10	288	248	2	-38	-38	800	600
10/28/10	to	11/26/10	11/29/10	to	12/03/10	450	410	2	0	0	1250	1010
11/04/10	to	12/03/10	12/06/10	to	12/10/10	0	0	0	0	0	1250	1010
11/11/10	to	12/10/10	12/13/10	to	12/17/10	0	0	0	0	0	1250	1010
11/18/10	to	12/17/10	12/20/10	to	12/24/10	0	0	0	0	0	1250	1010
11/25/10	to	12/24/10	12/27/10	to	12/31/10	0	0	0	0	0	1250	1010
12/02/10	to	12/31/10	01/03/11	to	01/07/11	(38)	(58)	1	-38	-38	1212	952
12/09/10	to	01/07/11	01/10/11	to	01/14/11	0	0	0	0	0	1212	952
12/16/10	to	01/14/11	01/17/11	to	01/21/11	(338)	(358)	1	-338	-338	874	594
12/23/10	to	01/21/11	01/24/11	to	01/28/11	0	0	0	0	0	874	594
12/30/10	to	01/28/11	01/31/11	to	02/04/11	438	418	1	0	0	1312	1012
01/06/11	to	02/04/11	02/07/11	to	02/11/11	0	0	0	0	0	1312	1012
01/13/11	to	02/11/11	02/14/11	to	02/18/11	0	0	0	0	0	1312	1012
01/20/11	to	02/18/11	02/21/11	to	02/25/11	100	80	1	0	0	1412	1092
01/27/11	to	02/25/11	02/28/11	to	03/04/11	0	0	0	0	0	1412	1092
02/03/11	to	03/04/11	03/07/11	to	03/11/11	0	0	0	0	0	1412	1092
02/10/11	to	03/11/11	03/14/11	to	03/18/11	(1600)	(1680)	4	-900	-1600	-188	-588
02/17/11	to	03/18/11	03/21/11	to	03/25/11	(25)	(45)	1	-25	-25	-213	-633
02/24/11	to	03/25/11	03/28/11	to	04/01/11	0	0	0	0	0	-213	-633
03/03/11	to	04/01/11	04/04/11	to	04/08/11	0	0	0	0	0	-213	-633
03/10/11	to	04/08/11	04/11/11	to	04/15/11	0	0	0	0	0	-213	-633
03/17/11	to	04/15/11	04/18/11	to	04/22/11	(150)	(190)	2	-263	-263	-363	-823
03/24/11	to	04/22/11	04/25/11	to	04/29/11	0	0	0	0	0	-363	-823
03/31/11	to	04/29/11	05/02/11	to	05/06/11	(413)	(433)	1	-413	-413	-776	-1256
04/07/11	to	05/06/11	05/09/11	to	05/13/11	0	0	0	0	0	-776	-1256
04/14/11	to	05/13/11	05/16/11	to	05/20/11	0	0	0	0	0	-776	-1256
04/21/11	to	05/20/11	05/23/11	to	05/27/11	13	(7)	1	0	0	-763	-1263
04/28/11	to	05/27/11	05/30/11	to	06/03/11	288	248	2	0	0	-475	-1015

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq
05/05/11	to	06/03/11	06/06/11	to	06/10/11	0	0	0	0	0	-475	-1015
05/12/11	to	06/10/11	06/13/11	to	06/17/11	0	0	0	0	0	-475	-1015
05/19/11	to	06/17/11	06/20/11	to	06/24/11	(163)	(223)	3	-650	-650	-638	-1238
05/26/11	to	06/24/11	06/27/11	to	07/01/11	438	418	1	0	0	-200	-820
06/02/11	to	07/01/11	07/04/11	to	07/08/11	25	(15)	2	-150	-150	-175	-835
06/09/11	to	07/08/11	07/11/11	to	07/15/11	50	10	2	-425	-425	-125	-825
06/16/11	to	07/15/11	07/18/11	to	07/22/11	613	553	3	-188	-188	488	-272
06/23/11	to	07/22/11	07/25/11	to	07/29/11	(675)	(735)	3	-625	-1163	-187	-1007
06/30/11	to	07/29/11	08/01/11	to	08/05/11	1175	1055	6	-688	-688	988	48
07/07/11	to	08/05/11	08/08/11	to	08/12/11	0	0	0	0	0	988	48
07/14/11	to	08/12/11	08/15/11	to	08/19/11	0	0	0	0	0	988	48
07/21/11	to	08/19/11	08/22/11	to	08/26/11	0	0	0	0	0	988	48
07/28/11	to	08/26/11	08/29/11	to	09/02/11	0	0	0	0	0	988	48
08/04/11	to	09/02/11	09/05/11	to	09/09/11	525	465	3	-863	-863	1513	513
08/11/11	to	09/09/11	09/12/11	to	09/16/11	(175)	(255)	4	-650	-650	1338	258
08/18/11	to	09/16/11	09/19/11	to	09/23/11	(1625)	(1745)	6	-900	-1738	-287	-1487
08/25/11	to	09/23/11	09/26/11	to	09/30/11	413	273	7	-713	-1238	126	-1214
09/01/11	to	09/30/11	10/03/11	to	10/07/11	4050	3950	5	-663	-663	4176	2736
09/08/11	to	10/07/11	10/10/11	to	10/14/11	513	433	4	-463	-463	4689	3169
09/15/11	to	10/14/11	10/17/11	to	10/21/11	1288	1228	3	0	0	5977	4397
09/22/11	to	10/21/11	10/24/11	to	10/28/11	2000	1920	4	0	0	7977	6317
09/29/11	to	10/28/11	10/31/11	to	11/04/11	638	518	6	-625	-938	8615	6835
10/06/11	to	11/04/11	11/07/11	to	11/11/11	1450	1370	4	0	0	10065	8205
10/13/11	to	11/11/11	11/14/11	to	11/18/11	475	415	3	-150	-150	10540	8620
10/20/11	to	11/18/11	11/21/11	to	11/25/11	413	373	2	0	0	10953	8993
10/27/11	to	11/25/11	11/28/11	to	12/02/11	(238)	(318)	4	-588	-588	10715	8675
11/03/11	to	12/02/11	12/05/11	to	12/09/11	(888)	(968)	4	-738	-1200	9827	7707
11/10/11	to	12/09/11	12/12/11	to	12/16/11	0	0	0	0	0	9827	7707
11/17/11	to	12/16/11	12/19/11	to	12/23/11	0	0	0	0	0	9827	7707
11/24/11	to	12/23/11	12/26/11	to	12/30/11	0	0	0	0	0	9827	7707
12/01/11	to	12/30/11	01/02/12	to	01/06/12	0	0	0	0	0	9827	7707
12/08/11	to	01/06/12	01/09/12	to	01/13/12	(75)	(95)	1	-75	-75	9752	7612
12/15/11	to	01/13/12	01/16/12	to	01/20/12	(363)	(383)	1	-363	-363	9389	7229
12/22/11	to	01/20/12	01/23/12	to	01/27/12	0	0	0	0	0	9389	7229
12/29/11	to	01/27/12	01/30/12	to	02/03/12	(100)	(160)	3	-463	-463	9289	7069
01/05/12	to	02/03/12	02/06/12	to	02/10/12	(188)	(208)	1	-188	-188	9101	6861
01/12/12	to	02/10/12	02/13/12	to	02/17/12	75	55	1	0	0	9176	6916
01/19/12	to	02/17/12	02/20/12	to	02/24/12	0	0	0	0	0	9176	6916
01/26/12	to	02/24/12	02/27/12	to	03/02/12	0	0	0	0	0	9176	6916
02/02/12	to	03/02/12	03/05/12	to	03/09/12	213	193	1	0	0	9389	7109
02/09/12	to	03/09/12	03/12/12	to	03/16/12	188	168	1	0	0	9577	7277
02/16/12	to	03/16/12	03/19/12	to	03/23/12	0	0	0	0	0	9577	7277
02/23/12	to	03/23/12	03/26/12	to	03/30/12	0	0	0	0	0	9577	7277
03/01/12	to	03/30/12	04/02/12	to	04/06/12	0	0	0	0	0	9577	7277
03/08/12	to	04/06/12	04/09/12	to	04/13/12	0	0	0	0	0	9577	7277
03/15/12	to	04/13/12	04/16/12	to	04/20/12	525	505	1	0	0	10102	7782
03/22/12	to	04/20/12	04/23/12	to	04/27/12	(188)	(228)	2	-250	-250	9914	7554
03/29/12	to	04/27/12	04/30/12	to	05/04/12	(150)	(170)	1	-150	-150	9764	7384
04/05/12	to	05/04/12	05/07/12	to	05/11/12	(500)	(540)	2	-388	-500	9264	6844
04/12/12	to	05/11/12	05/14/12	to	05/18/12	75	55	1	0	0	9339	6899
04/19/12	to	05/18/12	05/21/12	to	05/25/12	488	448	2	0	0	9827	7347
04/26/12	to	05/25/12	05/28/12	to	06/01/12	1000	940	3	0	0	10827	8287
05/03/12	to	06/01/12	06/04/12	to	06/08/12	125	65	3	-638	-638	10952	8352
05/10/12	to	06/08/12	06/11/12	to	06/15/12	225	205	1	0	0	11177	8557
05/17/12	to	06/15/12	06/18/12	to	06/22/12	113	93	1	0	0	11290	8650

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq
05/24/12	to	06/22/12	06/25/12	to	06/29/12	700	640	3	-63	-63	11990	9290
05/31/12	to	06/29/12	07/02/12	to	07/06/12	25	5	1	0	0	12015	9295
06/07/12	to	07/06/12	07/09/12	to	07/13/12	125	85	2	-313	-313	12140	9380
06/14/12	to	07/13/12	07/16/12	to	07/20/12	0	0	0	0	0	12140	9380
06/21/12	to	07/20/12	07/23/12	to	07/27/12	325	265	3	-525	-525	12465	9645
06/28/12	to	07/27/12	07/30/12	to	08/03/12	150	130	1	0	0	12615	9775
07/05/12	to	08/03/12	08/06/12	to	08/10/12	0	0	0	0	0	12615	9775
07/12/12	to	08/10/12	08/13/12	to	08/17/12	0	0	0	0	0	12615	9775
07/19/12	to	08/17/12	08/20/12	to	08/24/12	0	0	0	0	0	12615	9775
07/26/12	to	08/24/12	08/27/12	to	08/31/12	0	0	0	0	0	12615	9775
08/02/12	to	08/31/12	09/03/12	to	09/07/12	0	0	0	0	0	12615	9775
08/09/12	to	09/07/12	09/10/12	to	09/14/12	0	0	0	0	0	12615	9775
08/16/12	to	09/14/12	09/17/12	to	09/21/12	0	0	0	0	0	12615	9775
08/23/12	to	09/21/12	09/24/12	to	09/28/12	0	0	0	0	0	12615	9775
08/30/12	to	09/28/12	10/01/12	to	10/05/12	0	0	0	0	0	12615	9775
09/06/12	to	10/05/12	10/08/12	to	10/12/12	0	0	0	0	0	12615	9775
09/13/12	to	10/12/12	10/15/12	to	10/19/12	250	230	1	0	0	12865	10005
09/20/12	to	10/19/12	10/22/12	to	10/26/12	(138)	(178)	2	-225	-225	12727	9827
09/27/12	to	10/26/12	10/29/12	to	11/02/12	213	193	1	0	0	12940	10020
10/04/12	to	11/02/12	11/05/12	to	11/09/12	688	668	1	0	0	13628	10688
10/11/12	to	11/09/12	11/12/12	to	11/16/12	88	68	1	0	0	13716	10756
10/18/12	to	11/16/12	11/19/12	to	11/23/12	325	305	1	0	0	14041	11061
10/25/12	to	11/23/12	11/26/12	to	11/30/12	0	0	0	0	0	14041	11061
11/01/12	to	11/30/12	12/03/12	to	12/07/12	0	0	0	0	0	14041	11061
11/08/12	to	12/07/12	12/10/12	to	12/14/12	(88)	(108)	1	-88	-88	13953	10953
11/15/12	to	12/14/12	12/17/12	to	12/21/12	325	285	2	-100	-100	14278	11238
11/22/12	to	12/21/12	12/24/12	to	12/28/12	163	143	1	0	0	14441	11381
11/29/12	to	12/28/12	12/31/12	to	01/04/13	300	280	1	0	0	14741	11661
12/06/12	to	01/04/13	01/07/13	to	01/11/13	0	0	0	0	0	14741	11661
12/13/12	to	01/11/13	01/14/13	to	01/18/13	0	0	0	0	0	14741	11661
12/20/12	to	01/18/13	01/21/13	to	01/25/13	0	0	0	0	0	14741	11661
12/27/12	to	01/25/13	01/28/13	to	02/01/13	0	0	0	0	0	14741	11661
01/03/13	to	02/01/13	02/04/13	to	02/08/13	0	0	0	0	0	14741	11661
01/10/13	to	02/08/13	02/11/13	to	02/15/13	0	0	0	0	0	14741	11661
01/17/13	to	02/15/13	02/18/13	to	02/22/13	0	0	0	0	0	14741	11661
01/24/13	to	02/22/13	02/25/13	to	03/01/13	0	0	0	0	0	14741	11661
01/31/13	to	03/01/13	03/04/13	to	03/08/13	163	143	1	0	0	14904	11804
02/07/13	to	03/08/13	03/11/13	to	03/15/13	0	0	0	0	0	14904	11804
02/14/13	to	03/15/13	03/18/13	to	03/22/13	100	80	1	0	0	15004	11884
02/21/13	to	03/22/13	03/25/13	to	03/29/13	(450)	(490)	2	-625	-625	14554	11394
02/28/13	to	03/29/13	04/01/13	to	04/05/13	(650)	(690)	2	-625	-650	13904	10704
03/07/13	to	04/05/13	04/08/13	to	04/12/13	0	0	0	0	0	13904	10704
03/14/13	to	04/12/13	04/15/13	to	04/19/13	913	873	2	0	0	14817	11577
03/21/13	to	04/19/13	04/22/13	to	04/26/13	288	268	1	0	0	15105	11845
03/28/13	to	04/26/13	04/29/13	to	05/03/13	(38)	(58)	1	-38	-38	15067	11787
04/04/13	to	05/03/13	05/06/13	to	05/10/13	0	0	0	0	0	15067	11787
04/11/13	to	05/10/13	05/13/13	to	05/17/13	0	0	0	0	0	15067	11787
04/18/13	to	05/17/13	05/20/13	to	05/24/13	0	0	0	0	0	15067	11787
04/25/13	to	05/24/13	05/27/13	to	05/31/13	(675)	(735)	3	-600	-675	14392	11052
05/02/13	to	05/31/13	06/03/13	to	06/07/13	0	0	0	0	0	14392	11052
05/09/13	to	06/07/13	06/10/13	to	06/14/13	75	55	1	0	0	14467	11107
05/16/13	to	06/14/13	06/17/13	to	06/21/13	1013	953	3	-200	-200	15480	12060
05/23/13	to	06/21/13	06/24/13	to	06/28/13	(1988)	(2088)	5	-788	-1988	13492	9972
05/30/13	to	06/28/13	07/01/13	to	07/05/13	(13)	(53)	2	-450	-450	13479	9919
06/06/13	to	07/05/13	07/08/13	to	07/12/13	350	290	3	-100	-100	13829	10209

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq
06/13/13	to	07/12/13	07/15/13	to	07/19/13	0	0	0	0	0	13829	10209
06/20/13	to	07/19/13	07/22/13	to	07/26/13	0	0	0	0	0	13829	10209
06/27/13	to	07/26/13	07/29/13	to	08/02/13	288	268	1	0	0	14117	10477
07/04/13	to	08/02/13	08/05/13	to	08/09/13	0	0	0	0	0	14117	10477
07/11/13	to	08/09/13	08/12/13	to	08/16/13	0	0	0	0	0	14117	10477
07/18/13	to	08/16/13	08/19/13	to	08/23/13	0	0	0	0	0	14117	10477
07/25/13	to	08/23/13	08/26/13	to	08/30/13	713	693	1	0	0	14830	11170
08/01/13	to	08/30/13	09/02/13	to	09/06/13	(638)	(678)	2	-450	-638	14192	10492
08/08/13	to	09/06/13	09/09/13	to	09/13/13	175	155	1	0	0	14367	10647
08/15/13	to	09/13/13	09/16/13	to	09/20/13	38	(2)	2	-213	-213	14405	10645
08/22/13	to	09/20/13	09/23/13	to	09/27/13	0	0	0	0	0	14405	10645
08/29/13	to	09/27/13	09/30/13	to	10/04/13	(200)	(220)	1	-200	-200	14205	10425
09/05/13	to	10/04/13	10/07/13	to	10/11/13	675	655	1	0	0	14880	11080
09/12/13	to	10/11/13	10/14/13	to	10/18/13	213	193	1	0	0	15093	11273
09/19/13	to	10/18/13	10/21/13	to	10/25/13	13	(7)	1	0	0	15106	11266
09/26/13	to	10/25/13	10/28/13	to	11/01/13	0	0	0	0	0	15106	11266
10/03/13	to	11/01/13	11/04/13	to	11/08/13	0	0	0	0	0	15106	11266
10/10/13	to	11/08/13	11/11/13	to	11/15/13	0	0	0	0	0	15106	11266
10/17/13	to	11/15/13	11/18/13	to	11/22/13	0	0	0	0	0	15106	11266
10/24/13	to	11/22/13	11/25/13	to	11/29/13	0	0	0	0	0	15106	11266
10/31/13	to	11/29/13	12/02/13	to	12/06/13	(150)	(190)	2	-350	-350	14956	11076
11/07/13	to	12/06/13	12/09/13	to	12/13/13	0	0	0	0	0	14956	11076
11/14/13	to	12/13/13	12/16/13	to	12/20/13	913	873	2	-238	-238	15869	11949
11/21/13	to	12/20/13	12/23/13	to	12/27/13	0	0	0	0	0	15869	11949
11/28/13	to	12/27/13	12/30/13	to	01/03/14	0	0	0	0	0	15869	11949
12/05/13	to	01/03/14	01/06/14	to	01/10/14	0	0	0	0	0	15869	11949
12/12/13	to	01/10/14	01/13/14	to	01/17/14	0	0	0	0	0	15869	11949
12/19/13	to	01/17/14	01/20/14	to	01/24/14	1075	1015	3	-188	-188	16944	12964
12/26/13	to	01/24/14	01/27/14	to	01/31/14	0	0	0	0	0	16944	12964
01/02/14	to	01/31/14	02/03/14	to	02/07/14	2213	2113	5	-38	-38	19157	15077
01/09/14	to	02/07/14	02/10/14	to	02/14/14	0	0	0	0	0	19157	15077
01/16/14	to	02/14/14	02/17/14	to	02/21/14	0	0	0	0	0	19157	15077
01/23/14	to	02/21/14	02/24/14	to	02/28/14	(313)	(353)	2	-175	-313	18844	14724
01/30/14	to	02/28/14	03/03/14	to	03/07/14	113	73	2	-113	-113	18957	14797
02/06/14	to	03/07/14	03/10/14	to	03/14/14	0	0	0	0	0	18957	14797
02/13/14	to	03/14/14	03/17/14	to	03/21/14	(488)	(548)	3	-725	-725	18469	14249
02/20/14	to	03/21/14	03/24/14	to	03/28/14	(625)	(685)	3	-263	-625	17844	13564
02/27/14	to	03/28/14	03/31/14	to	04/04/14	0	0	0	0	0	17844	13564
03/06/14	to	04/04/14	04/07/14	to	04/11/14	0	0	0	0	0	17844	13564
03/13/14	to	04/11/14	04/14/14	to	04/18/14	0	0	0	0	0	17844	13564
03/20/14	to	04/18/14	04/21/14	to	04/25/14	0	0	0	0	0	17844	13564
03/27/14	to	04/25/14	04/28/14	to	05/02/14	(75)	(95)	1	-75	-75	17769	13469
04/03/14	to	05/02/14	05/05/14	to	05/09/14	138	118	1	0	0	17907	13587
04/10/14	to	05/09/14	05/12/14	to	05/16/14	163	123	2	-63	-63	18070	13710
04/17/14	to	05/16/14	05/19/14	to	05/23/14	238	218	1	0	0	18308	13928
04/24/14	to	05/23/14	05/26/14	to	05/30/14	0	0	0	0	0	18308	13928
05/01/14	to	05/30/14	06/02/14	to	06/06/14	0	0	0	0	0	18308	13928
05/08/14	to	06/06/14	06/09/14	to	06/13/14	0	0	0	0	0	18308	13928
05/15/14	to	06/13/14	06/16/14	to	06/20/14	0	0	0	0	0	18308	13928
05/22/14	to	06/20/14	06/23/14	to	06/27/14	0	0	0	0	0	18308	13928
05/29/14	to	06/27/14	06/30/14	to	07/04/14	0	0	0	0	0	18308	13928
06/05/14	to	07/04/14	07/07/14	to	07/11/14	0	0	0	0	0	18308	13928
06/12/14	to	07/11/14	07/14/14	to	07/18/14	(13)	(33)	1	-13	-13	18295	13895
06/19/14	to	07/18/14	07/21/14	to	07/25/14	(100)	(120)	1	-100	-100	18195	13775
06/26/14	to	07/25/14	07/28/14	to	08/01/14	1138	1118	1	0	0	19333	14893

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq
07/03/14	to	08/01/14	08/04/14	to	08/08/14	213	193	1	0	0	19546	15086
07/10/14	to	08/08/14	08/11/14	to	08/15/14	(188)	(208)	1	-188	-188	19358	14878
07/17/14	to	08/15/14	08/18/14	to	08/22/14	138	118	1	0	0	19496	14996
07/24/14	to	08/22/14	08/25/14	to	08/29/14	0	0	0	0	0	19496	14996
07/31/14	to	08/29/14	09/01/14	to	09/05/14	0	0	0	0	0	19496	14996
08/07/14	to	09/05/14	09/08/14	to	09/12/14	0	0	0	0	0	19496	14996
08/14/14	to	09/12/14	09/15/14	to	09/19/14	175	155	1	0	0	19671	15151
08/21/14	to	09/19/14	09/22/14	to	09/26/14	0	0	0	0	0	19671	15151
08/28/14	to	09/26/14	09/29/14	to	10/03/14	0	0	0	0	0	19671	15151
09/04/14	to	10/03/14	10/06/14	to	10/10/14	475	375	5	-1225	-1925	20146	15526
09/11/14	to	10/10/14	10/13/14	to	10/17/14	2675	2535	7	-650	-650	22821	18061
09/18/14	to	10/17/14	10/20/14	to	10/24/14	1188	1148	2	0	0	24009	19209
09/25/14	to	10/24/14	10/27/14	to	10/31/14	975	935	2	0	0	24984	20144
10/02/14	to	10/31/14	11/03/14	to	11/07/14	0	0	0	0	0	24984	20144
10/09/14	to	11/07/14	11/10/14	to	11/14/14	0	0	0	0	0	24984	20144
10/16/14	to	11/14/14	11/17/14	to	11/21/14	0	0	0	0	0	24984	20144
10/23/14	to	11/21/14	11/24/14	to	11/28/14	0	0	0	0	0	24984	20144
10/30/14	to	11/28/14	12/01/14	to	12/05/14	0	0	0	0	0	24984	20144
11/06/14	to	12/05/14	12/08/14	to	12/12/14	(688)	(748)	3	-525	-688	24296	19396
11/13/14	to	12/12/14	12/15/14	to	12/19/14	1650	1490	8	-700	-1675	25946	20886
11/20/14	to	12/19/14	12/22/14	to	12/26/14	0	0	0	0	0	25946	20886
11/27/14	to	12/26/14	12/29/14	to	01/02/15	0	0	0	0	0	25946	20886
12/04/14	to	01/02/15	01/05/15	to	01/09/15	1000	900	5	-475	-475	26946	21786
12/11/14	to	01/09/15	01/12/15	to	01/16/15	(813)	(933)	6	-1500	-1638	26133	20853
12/18/14	to	01/16/15	01/19/15	to	01/23/15	750	710	2	-188	-188	26883	21563
12/25/14	to	01/23/15	01/26/15	to	01/30/15	(1775)	(1895)	6	-1825	-2075	25108	19668
01/01/15	to	01/30/15	02/02/15	to	02/06/15	1225	1145	4	-750	-750	26333	20813
01/08/15	to	02/06/15	02/09/15	to	02/13/15	1100	1060	2	0	0	27433	21873
01/15/15	to	02/13/15	02/16/15	to	02/20/15	0	0	0	0	0	27433	21873
01/22/15	to	02/20/15	02/23/15	to	02/27/15	0	0	0	0	0	27433	21873
01/29/15	to	02/27/15	03/02/15	to	03/06/15	(300)	(320)	1	-300	-300	27133	21553
02/05/15	to	03/06/15	03/09/15	to	03/13/15	1125	1085	2	0	0	28258	22638
02/12/15	to	03/13/15	03/16/15	to	03/20/15	1475	1415	3	0	0	29733	24053
02/19/15	to	03/20/15	03/23/15	to	03/27/15	0	0	0	0	0	29733	24053
02/26/15	to	03/27/15	03/30/15	to	04/03/15	0	0	0	0	0	29733	24053
03/05/15	to	04/03/15	04/06/15	to	04/10/15	213	193	1	0	0	29946	24246
03/12/15	to	04/10/15	04/13/15	to	04/17/15	250	210	2	0	0	30196	24456
03/19/15	to	04/17/15	04/20/15	to	04/24/15	288	248	2	0	0	30484	24704
03/26/15	to	04/24/15	04/27/15	to	05/01/15	838	798	2	0	0	31322	25502
04/02/15	to	05/01/15	05/04/15	to	05/08/15	0	0	0	0	0	31322	25502
04/09/15	to	05/08/15	05/11/15	to	05/15/15	0	0	0	0	0	31322	25502
04/16/15	to	05/15/15	05/18/15	to	05/22/15	0	0	0	0	0	31322	25502
04/23/15	to	05/22/15	05/25/15	to	05/29/15	863	823	2	0	0	32185	26325
04/30/15	to	05/29/15	06/01/15	to	06/05/15	(363)	(383)	1	-363	-363	31822	25942
05/07/15	to	06/05/15	06/08/15	to	06/12/15	525	505	1	0	0	32347	26447
05/14/15	to	06/12/15	06/15/15	to	06/19/15	(275)	(335)	3	-475	-738	32072	26112
05/21/15	to	06/19/15	06/22/15	to	06/26/15	(88)	(108)	1	-88	-88	31984	26004
05/28/15	to	06/26/15	06/29/15	to	07/03/15	713	653	3	-600	-738	32697	26657
06/04/15	to	07/03/15	07/06/15	to	07/10/15	113	13	5	-963	-963	32810	26670
06/11/15	to	07/10/15	07/13/15	to	07/17/15	425	385	2	0	0	33235	27055
06/18/15	to	07/17/15	07/20/15	to	07/24/15	0	0	0	0	0	33235	27055
06/25/15	to	07/24/15	07/27/15	to	07/31/15	63	43	1	0	0	33298	27098
07/02/15	to	07/31/15	08/03/15	to	08/07/15	(425)	(445)	1	-425	-425	32873	26653
07/09/15	to	08/07/15	08/10/15	to	08/14/15	1425	1345	4	-150	-150	34298	27998
07/16/15	to	08/14/15	08/17/15	to	08/21/15	3075	2975	5	-638	-1238	37373	30973

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq
07/23/15	to	08/21/15	08/24/15	to	08/28/15	4775	4575	10	-800	-1263	42148	35548
07/30/15	to	08/28/15	08/31/15	to	09/04/15	600	480	6	-600	-1275	42748	36028
08/06/15	to	09/04/15	09/07/15	to	09/11/15	913	813	5	-1063	-1063	43661	36841
08/13/15	to	09/11/15	09/14/15	to	09/18/15	(38)	(118)	4	-1100	-1100	43623	36723
08/20/15	to	09/18/15	09/21/15	to	09/25/15	(1875)	(1995)	6	-888	-1913	41748	34728
08/27/15	to	09/25/15	09/28/15	to	10/02/15	0	0	0	0	0	41748	34728
09/03/15	to	10/02/15	10/05/15	to	10/09/15	0	0	0	0	0	41748	34728
09/10/15	to	10/09/15	10/12/15	to	10/16/15	0	0	0	0	0	41748	34728
09/17/15	to	10/16/15	10/19/15	to	10/23/15	0	0	0	0	0	41748	34728
09/24/15	to	10/23/15	10/26/15	to	10/30/15	0	0	0	0	0	41748	34728
10/01/15	to	10/30/15	11/02/15	to	11/06/15	(325)	(385)	3	-675	-1063	41423	34343
10/08/15	to	11/06/15	11/09/15	to	11/13/15	1300	1240	3	0	0	42723	35583
10/15/15	to	11/13/15	11/16/15	to	11/20/15	175	115	3	-638	-638	42898	35698
10/22/15	to	11/20/15	11/23/15	to	11/27/15	363	343	1	0	0	43261	36041
10/29/15	to	11/27/15	11/30/15	to	12/04/15	1413	1373	2	0	0	44674	37414
11/05/15	to	12/04/15	12/07/15	to	12/11/15	(1163)	(1283)	6	-788	-1925	43511	36131
11/12/15	to	12/11/15	12/14/15	to	12/18/15	2625	2545	4	-238	-238	46136	38676
11/19/15	to	12/18/15	12/21/15	to	12/25/15	1488	1428	3	0	0	47624	40104
11/26/15	to	12/25/15	12/28/15	to	01/01/16	463	403	3	-225	-225	48087	40507
12/03/15	to	01/01/16	01/04/16	to	01/08/16	(3150)	(3310)	8	-1500	-3200	44937	37197
12/10/15	to	01/08/16	01/11/16	to	01/15/16	1300	1200	5	-163	-163	46237	38397
12/17/15	to	01/15/16	01/18/16	to	01/22/16	2075	1975	5	-500	-500	48312	40372
12/24/15	to	01/22/16	01/25/16	to	01/29/16	50	(110)	8	-1038	-1913	48362	40262
12/31/15	to	01/29/16	02/01/16	to	02/05/16	1263	1123	7	-850	-850	49625	41385
01/07/16	to	02/05/16	02/08/16	to	02/12/16	1425	1285	7	-913	-913	51050	42670
01/14/16	to	02/12/16	02/15/16	to	02/19/16	1425	1385	2	0	0	52475	44055
01/21/16	to	02/19/16	02/22/16	to	02/26/16	(125)	(205)	4	-725	-725	52350	43850
01/28/16	to	02/26/16	02/29/16	to	03/04/16	1500	1460	2	0	0	53850	45310
02/04/16	to	03/04/16	03/07/16	to	03/11/16	363	263	5	-963	-963	54213	45573
02/11/16	to	03/11/16	03/14/16	to	03/18/16	(338)	(378)	2	-463	-463	53875	45195
02/18/16	to	03/18/16	03/21/16	to	03/25/16	(463)	(483)	1	-463	-463	53412	44712
02/25/16	to	03/25/16	03/28/16	to	04/01/16	238	158	4	-550	-788	53650	44870
03/03/16	to	04/01/16	04/04/16	to	04/08/16	238	178	3	-525	-525	53888	45048
03/10/16	to	04/08/16	04/11/16	to	04/15/16	(63)	(123)	3	-863	-863	53825	44925
03/17/16	to	04/15/16	04/18/16	to	04/22/16	275	255	1	0	0	54100	45180
03/24/16	to	04/22/16	04/25/16	to	04/29/16	(713)	(793)	4	-225	-713	53387	44387
03/31/16	to	04/29/16	05/02/16	to	05/06/16	0	0	0	0	0	53387	44387
04/07/16	to	05/06/16	05/09/16	to	05/13/16	0	0	0	0	0	53387	44387
04/14/16	to	05/13/16	05/16/16	to	05/20/16	0	0	0	0	0	53387	44387
04/21/16	to	05/20/16	05/23/16	to	05/27/16	0	0	0	0	0	53387	44387
04/28/16	to	05/27/16	05/30/16	to	06/03/16	0	0	0	0	0	53387	44387
05/05/16	to	06/03/16	06/06/16	to	06/10/16	0	0	0	0	0	53387	44387
05/12/16	to	06/10/16	06/13/16	to	06/17/16	0	0	0	0	0	53387	44387
05/19/16	to	06/17/16	06/20/16	to	06/24/16	(1650)	(1730)	4	-1538	-1663	51737	42657
05/26/16	to	06/24/16	06/27/16	to	07/01/16	1675	1595	4	-125	-125	53412	44252
06/02/16	to	07/01/16	07/04/16	to	07/08/16	738	658	4	-538	-538	54150	44910
06/09/16	to	07/08/16	07/11/16	to	07/15/16	38	(22)	3	-113	-113	54188	44888
06/16/16	to	07/15/16	07/18/16	to	07/22/16	0	0	0	0	0	54188	44888
06/23/16	to	07/22/16	07/25/16	to	07/29/16	0	0	0	0	0	54188	44888
06/30/16	to	07/29/16	08/01/16	to	08/05/16	138	118	1	0	0	54326	45006
07/07/16	to	08/05/16	08/08/16	to	08/12/16	0	0	0	0	0	54326	45006
07/14/16	to	08/12/16	08/15/16	to	08/19/16	0	0	0	0	0	54326	45006
07/21/16	to	08/19/16	08/22/16	to	08/26/16	0	0	0	0	0	54326	45006
07/28/16	to	08/26/16	08/29/16	to	09/02/16	(100)	(140)	2	-200	-200	54226	44866
08/04/16	to	09/02/16	09/05/16	to	09/09/16	1625	1605	1	0	0	55851	46471

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq
08/11/16	to	09/09/16	09/12/16	to	09/16/16	888	808	4	-625	-688	56739	47279
08/18/16	to	09/16/16	09/19/16	to	09/23/16	(150)	(210)	3	-725	-725	56589	47069
08/25/16	to	09/23/16	09/26/16	to	09/30/16	(625)	(685)	3	-413	-825	55964	46384
09/01/16	to	09/30/16	10/03/16	to	10/07/16	(150)	(190)	2	-138	-150	55814	46194
09/08/16	to	10/07/16	10/10/16	to	10/14/16	0	0	0	0	0	55814	46194
09/15/16	to	10/14/16	10/17/16	to	10/21/16	0	0	0	0	0	55814	46194
09/22/16	to	10/21/16	10/24/16	to	10/28/16	0	0	0	0	0	55814	46194
09/29/16	to	10/28/16	10/31/16	to	11/04/16	0	0	0	0	0	55814	46194
10/06/16	to	11/04/16	11/07/16	to	11/11/16	75	(25)	5	-925	-1538	55889	46169
10/13/16	to	11/11/16	11/14/16	to	11/18/16	0	0	0	0	0	55889	46169
10/20/16	to	11/18/16	11/21/16	to	11/25/16	250	230	1	0	0	56139	46399
10/27/16	to	11/25/16	11/28/16	to	12/02/16	0	0	0	0	0	56139	46399
11/03/16	to	12/02/16	12/05/16	to	12/09/16	250	210	2	-100	-100	56389	46609
11/10/16	to	12/09/16	12/12/16	to	12/16/16	(100)	(140)	2	-175	-175	56289	46469
11/17/16	to	12/16/16	12/19/16	to	12/23/16	(50)	(70)	1	-50	-50	56239	46399
11/24/16	to	12/23/16	12/26/16	to	12/30/16	(225)	(245)	1	-225	-225	56014	46154
12/01/16	to	12/30/16	01/02/17	to	01/06/17	288	248	2	0	0	56302	46402
12/08/16	to	01/06/17	01/09/17	to	01/13/17	(650)	(670)	1	-650	-650	55652	45732
12/15/16	to	01/13/17	01/16/17	to	01/20/17	(213)	(233)	1	-213	-213	55439	45499
12/22/16	to	01/20/17	01/23/17	to	01/27/17	300	280	1	0	0	55739	45779
12/29/16	to	01/27/17	01/30/17	to	02/03/17	(125)	(185)	3	-313	-463	55614	45594
01/05/17	to	02/03/17	02/06/17	to	02/10/17	0	0	0	0	0	55614	45594
01/12/17	to	02/10/17	02/13/17	to	02/17/17	0	0	0	0	0	55614	45594
01/19/17	to	02/17/17	02/20/17	to	02/24/17	175	155	1	0	0	55789	45749
01/26/17	to	02/24/17	02/27/17	to	03/03/17	475	455	1	0	0	56264	46204
02/02/17	to	03/03/17	03/06/17	to	03/10/17	0	0	0	0	0	56264	46204
02/09/17	to	03/10/17	03/13/17	to	03/17/17	0	0	0	0	0	56264	46204
02/16/17	to	03/17/17	03/20/17	to	03/24/17	775	755	1	0	0	57039	46959
02/23/17	to	03/24/17	03/27/17	to	03/31/17	0	0	0	0	0	57039	46959
03/02/17	to	03/31/17	04/03/17	to	04/07/17	(650)	(690)	2	-863	-863	56389	46269
03/09/17	to	04/07/17	04/10/17	to	04/14/17	0	0	0	0	0	56389	46269
03/16/17	to	04/14/17	04/17/17	to	04/21/17	0	0	0	0	0	56389	46269
03/23/17	to	04/21/17	04/24/17	to	04/28/17	125	85	2	0	0	56514	46354
03/30/17	to	04/28/17	05/01/17	to	05/05/17	0	0	0	0	0	56514	46354
04/06/17	to	05/05/17	05/08/17	to	05/12/17	0	0	0	0	0	56514	46354
04/13/17	to	05/12/17	05/15/17	to	05/19/17	1113	1033	4	-50	-50	57627	47387
04/20/17	to	05/19/17	05/22/17	to	05/26/17	213	173	2	0	0	57840	47560
04/27/17	to	05/26/17	05/29/17	to	06/02/17	0	0	0	0	0	57840	47560
05/04/17	to	06/02/17	06/05/17	to	06/09/17	0	0	0	0	0	57840	47560
05/11/17	to	06/09/17	06/12/17	to	06/16/17	(175)	(215)	2	-413	-413	57665	47345
05/18/17	to	06/16/17	06/19/17	to	06/23/17	375	355	1	0	0	58040	47700
05/25/17	to	06/23/17	06/26/17	to	06/30/17	(188)	(228)	2	-550	-550	57852	47472
06/01/17	to	06/30/17	07/03/17	to	07/07/17	(225)	(265)	2	-588	-588	57627	47207
06/08/17	to	07/07/17	07/10/17	to	07/14/17	38	18	1	0	0	57665	47225
06/15/17	to	07/14/17	07/17/17	to	07/21/17	0	0	0	0	0	57665	47225
06/22/17	to	07/21/17	07/24/17	to	07/28/17	(600)	(620)	1	-600	-600	57065	46605
06/29/17	to	07/28/17	07/31/17	to	08/04/17	0	0	0	0	0	57065	46605
07/06/17	to	08/04/17	08/07/17	to	08/11/17	913	893	1	0	0	57978	47498
07/13/17	to	08/11/17	08/14/17	to	08/18/17	163	143	1	0	0	58141	47641
07/20/17	to	08/18/17	08/21/17	to	08/25/17	200	160	2	-375	-375	58341	47801
07/27/17	to	08/25/17	08/28/17	to	09/01/17	200	180	1	0	0	58541	47981
08/03/17	to	09/01/17	09/04/17	to	09/08/17	0	0	0	0	0	58541	47981
08/10/17	to	09/08/17	09/11/17	to	09/15/17	313	293	1	0	0	58854	48274
08/17/17	to	09/15/17	09/18/17	to	09/22/17	0	0	0	0	0	58854	48274
08/24/17	to	09/22/17	09/25/17	to	09/29/17	0	0	0	0	0	58854	48274

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp\$20	ont	ollt	odd	EQ	NetEq
08/31/17	to	09/29/17	10/02/17	to	10/06/17	0	0	0	0	0	58854	48274
09/07/17	to	10/06/17	10/09/17	to	10/13/17	0	0	0	0	0	58854	48274
09/14/17	to	10/13/17	10/16/17	to	10/20/17	(475)	(515)	2	-750	-750	58379	47759
09/21/17	to	10/20/17	10/23/17	to	10/27/17	413	393	1	0	0	58792	48152
09/28/17	to	10/27/17	10/30/17	to	11/03/17	(400)	(420)	1	-400	-400	58392	47732
10/05/17	to	11/03/17	11/06/17	to	11/10/17	(225)	(245)	1	-225	-225	58167	47487
10/12/17	to	11/10/17	11/13/17	to	11/17/17	238	198	2	-263	-263	58405	47685
10/19/17	to	11/17/17	11/20/17	to	11/24/17	138	118	1	0	0	58543	47803
10/26/17	to	11/24/17	11/27/17	to	12/01/17	988	908	4	-238	-238	59531	48711
11/02/17	to	12/01/17	12/04/17	to	12/08/17	(888)	(928)	2	-1138	-1138	58643	47783
11/09/17	to	12/08/17	12/11/17	to	12/15/17	475	455	1	0	0	59118	48238
11/16/17	to	12/15/17	12/18/17	to	12/22/17	(75)	(95)	1	-75	-75	59043	48143
11/23/17	to	12/22/17	12/25/17	to	12/29/17	0	0	0	0	0	59043	48143
11/30/17	to	12/29/17	01/01/18	to	01/05/18	538	478	3	-88	-88	59581	48621
12/07/17	to	01/05/18	01/08/18	to	01/12/18	0	0	0	0	0	59581	48621
12/14/17	to	01/12/18	01/15/18	to	01/19/18	(1488)	(1508)	1	-1488	-1488	58093	47113
12/21/17	to	01/19/18	01/22/18	to	01/26/18	800	700	5	-888	-1050	58893	47813
12/28/17	to	01/26/18	01/29/18	to	02/02/18	500	400	5	-588	-1463	59393	48213
01/04/18	to	02/02/18	02/05/18	to	02/09/18	0	0	0	0	0	59393	48213
01/11/18	to	02/09/18	02/12/18	to	02/16/18	0	0	0	0	0	59393	48213
01/18/18	to	02/16/18	02/19/18	to	02/23/18	0	0	0	0	0	59393	48213
01/25/18	to	02/23/18	02/26/18	to	03/02/18	0	0	0	0	0	59393	48213
02/01/18	to	03/02/18	03/05/18	to	03/09/18	0	0	0	0	0	59393	48213
02/08/18	to	03/09/18	03/12/18	to	03/16/18	(2638)	(2698)	3	-1638	-2638	56755	45515
02/15/18	to	03/16/18	03/19/18	to	03/23/18	1775	1575	10	-1063	-1738	58530	47090
02/22/18	to	03/23/18	03/26/18	to	03/30/18	700	520	9	-1213	-1913	59230	47610
03/01/18	to	03/30/18	04/02/18	to	04/06/18	6575	6415	8	-763	-763	65805	54025
03/08/18	to	04/06/18	04/09/18	to	04/13/18	413	273	7	-688	-1325	66218	54298
03/15/18	to	04/13/18	04/16/18	to	04/20/18	1100	1020	4	0	0	67318	55318
03/22/18	to	04/20/18	04/23/18	to	04/27/18	(25)	(125)	5	-1200	-1200	67293	55193
03/29/18	to	04/27/18	04/30/18	to	05/04/18	2413	2253	8	-863	-863	69706	57446
04/05/18	to	05/04/18	05/07/18	to	05/11/18	950	850	5	-600	-763	70656	58296
04/12/18	to	05/11/18	05/14/18	to	05/18/18	(1075)	(1155)	4	-500	-1075	69581	57141
04/19/18	to	05/18/18	05/21/18	to	05/25/18	50	(10)	3	-463	-463	69631	57131

Appendix: The Normalization Multiplier

What is the Multiplier ?

The Least Square Velocity, is the least square fit of a of a straight to a set of prices

If you are fitting the straight line to N prices then the “Best Fit” coefficients **a** and **b** can be solved for easily and are given by

$$\mathbf{a} = [2(2N+1)/N(N-1)] \sum_1^N p(t) - [6/(N(N-1))] \sum_1^N t * p(t)$$

$$\mathbf{b} = \text{Velocity} = [12/N(N^2 - 1)] \sum_1^N t * p(t) - [6/N(N-1)] \sum_1^N p(t)$$

Where **p(t)** is the price at point time point **t** and **N** is the number of prices we are using to calculate the coefficients. Here **p(1)** is the first price in the series and **p(N)** is the last price in the series.

One of the inputs to the calculation of Velocity is the **N**, the number of lookback bars. When we plot the velocity we notice that the amplitude, and the maximum and minimum values of the velocity vary quite significantly with different **N** inputs.

Below is a table of the standard deviation of the 2,398,477 calculated Velocity values for different **N**. We used 1 min bars of the ES from 4/1/2010 to 4/28/2017 to generate this table.

ES1min 1 min bars Date Range 1100401 to 1170428
Total Number of Bars=2398747 sqrt(N)Norm=0
Trading Times Constraint Start Time=0 EndTime=0

LSqVelocity Multiplier to Scale Velocity N Range to One Std
20 Std=0.000052 1/Std=19354
30 Std=0.000042 1/Std=23842
40 Std=0.000036 1/Std=27584
50 Std=0.000032 1/Std=30856
60 Std=0.000030 1/Std=33800
70 Std=0.000027 1/Std=36502

1/Std Mult Ave=28656

As one can see the Velocity Standard Deviation for N=20 is approximately 2 times the SD for N=70. This makes it difficult to find a set of vup and vdn that satisfy all N. We would like to find a multiplier of the Velocity that normalizes all the N SDs and ranges to the same SDs.

Fortunately the SDs for the different Ns for a Least Squares Velocity are proportional to \sqrt{N} . So if we multiply the Velocity by the \sqrt{N} , the Velocities for different N should have the same SDs and ranges. Below are the results for multiplying the Velocity by \sqrt{N} .

ES1min 1 min bars Date Range 1100401 to 1170428
Total Number of Bars=2398747 sqrt(N)Norm=1
Trading Times Constraint Start Time=0 EndTime=0

LSqVelocity Multiplier to Scale Velocity N Range to One Std

20 Std=0.000231 1/Std=4327.8

30 Std=0.000230 1/Std=4352.9

40 Std=0.000229 1/Std=4361.5

50 Std=0.000229 1/Std=4363.7

60 Std=0.000229 1/Std=4363.6

70 Std=0.000229 1/Std=4362.8

1/Std Mult Ave=4355.4

As we can see the SDs are now very close. If we multiply all velocities by $4355 \cdot \sqrt{N}$ then the SDs of the velocities for all will be normalized to 1. This allows us to do an optimization search for ranges of v_{up} and v_{dn} from 0.2 to 3.6 standard deviations for all N.