

# Trading the ES 1 Min Bars With The Least Squares Acceleration Strategy

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In previous working papers [Ref below] we examined a trading strategy that used the velocity of prices fit by a straight line, through  $N$  past prices, to determine buy and sell points. The reasoning behind this type of strategy was to only trade when the price trend velocity was above a certain threshold. Many times prices meander around without a notable trend. At these times we do not wish to trade because of the whipsaw 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 value. Thus the velocity strategy would only issue a trade when certain velocity barriers were crossed. Acceleration is the change in velocity per unit time. In order for velocity to reach a certain value the price changes must start accelerating. Thus acceleration should be an even earlier indicator than velocity that prices are starting to trend. Unfortunately to find acceleration we cannot use the straight line formula of the previous articles. Straight lines have only constant velocities and no acceleration. We have to use a 2<sup>nd</sup> order polynomial to fit  $N$  past prices in order to find the price acceleration.

## The Best Fit 2<sup>nd</sup> Order Polynomial Line.

Let us imagine a set of closing prices on a graph with time as the horizontal axis and price as the vertical axis. Let us further suppose that we have only twenty closing price dots at twenty time intervals. How can we draw a 2<sup>nd</sup> order polynomial (also called a parabolic) through those twenty prices such that the sum of all the squared differences between the prices at each time interval and the parabolic line that is being fit to the data is minimized? This is called the “Least Squares Fit” of the data. This mathematical technique is available in most of today’s technical analysis software.

The formula for the 2<sup>nd</sup> order polynomial is:

$$p(t)_{EST} = a + b*t + c*t^2$$

Where  $p(t)_{EST}$  is the estimated price found from the least squares fit at time  $t$ ,  $a$  is the initial value of the line,  $b$  is the slope of the line,  $2c$  is the acceleration and  $t$  is the time of the bar. Recall that velocity is defined as the change of position per unit time and acceleration is defined as the rate of change of velocity per unit time. Using the formula above acceleration would be the second derivative of  $p(t)_{EST}$  and would be  $2c$ .

We can show this by using simple algebra on successive data bars

$$\text{Velocity}(t) = p(t)_{EST} - p(t-1)_{EST} = [a+b*t+c*t^2] - [a+b*(t-1)+c(t-1)^2] = b+2c*t-c$$

$$\text{Acceleration}(t) = \text{Velocity}(t) - \text{Velocity}(t-1) = [b+2c*t-c] - [b+2c*(t-1)-c] = 2c$$

If you are fitting a 2<sup>nd</sup> order polynomial to  $N$  prices then the Least Squares Fit of the acceleration  $c$  are obtained from the solution of the following matrix equation.

$$\begin{bmatrix} T & \Sigma t & \Sigma t^2 \\ \Sigma t & \Sigma t^2 & \Sigma t^3 \\ \Sigma t^2 & \Sigma t^3 & \Sigma t^4 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} \Sigma p(t) \\ \Sigma (p(t)*t) \\ \Sigma (p(t)*t^2) \end{bmatrix}$$

where

$p(T)$  is today's price,  $p(T-1)$  is yesterday's price and  $p(1)$  is the price  $T$  days ago.

$\Sigma p(t)$  is the summation of prices from  $t=1$  to  $T$  days

$\Sigma p(t)*t$  is the summation of prices times  $t$  from  $t=1$  to  $T$  days

$\Sigma t$  is the summation of the integer  $t$  from  $t=1$  to  $T$  days

$\Sigma t^2$  is the summation of the integer  $t$  squared from  $t=1$  to  $T$  days

etc.

Where all summations are from  $t=1$  to  $N$ .  $2c(t)$  is the acceleration at point  $t$  and  $N$  is the number of prices we are using to calculate the coefficients.

Programs that solve for the solution to matrix equations can be found in the book "Numerical Recipes" by W. Press, et. al. which is currently available in book stores. The programs in this book can be translated into TradeStation's EasyLanguage™.

While these matrix equations are correct, the implementation of them may cause a few computational problems. The first problem is slow speed. The computation of the polynomial coefficients at each bar using the matrix equations above is very slow. The second problem is floating point overflow. The summations in the polynomial coefficients can become very large causing floating point overflow and computational errors. To solve these problems I developed a fast efficient algorithm, similar to the Lagrange coefficients method discussed in the Nth Order Polynomial papers, that solves the above noted numerical floating point overflow problems and is super fast.

Here we will use the acceleration formula of the least squares 2<sup>nd</sup> order polynomial line to create a strategy. The least squares acceleration has the advantage that it is a natural random price noise inhibitor. We can create a strategy such that unless the acceleration from fitting  $N$  past price bars with a 2<sup>nd</sup> order polynomial 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 over a short period of time. With a lot of strategies this back and forth movement creates many false buy and sell signals. However using the least squares acceleration over  $N$  past prices, we can filter out many of the small price noise movements by requiring that the acceleration be greater than some threshold before we act.

### The Least Squares Acceleration System Defined

At each bar we calculate the least squares **acceleration** or  $2c$  from the formula above. When the acceleration is greater than the threshold amount ***aup*** we will go long. When the acceleration is less than the threshold amount ***-adn*** we will go short.

### **Buy Rule:**

**IF Acceleration** is greater than the threshold amount *aup* then buy at the market.

### **Sell Rule:**

**IF Acceleration** is less than the threshold amount *-adn* then sell at the market.

### **Intraday Bars Exit Rule:**

Close all positions 15 minutes before the ES close (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&P500 Index E-Mini Future 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 four years from September 2, 2010 to October 3, 2014

## **Testing The Least Squares Acceleration Strategy(LSqA) Using Walk Forward Optimization**

There are three strategy inputs to determine:

1. *N*, is the lookback period to calculate the **LSqA**.
2. *aup*, the threshold amount that LsqA has to be greater than to issue a buy signal
3. *adn*, the threshold amount that LsqA has to be less than to issue a sell signal

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

What do we mean by "*curve fitting*" or *data mining*? As a simple example, suppose you were taking a subway to work. In the subway car you are in, suppose you counted the number of

blond women in that car and suppose the percent of blond women vs all other women hair colors was 80%. Being that you can't observe what is in the other subway cars, you would assume that all the other subway cars and perhaps all women had the same percentage of blond hair. This observation was due to chance. That is an example of curve fitting. The same goes for combinatorial searches. You are observing results from a finite sample of data without knowing the data outside the sample you examined.

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

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

For the test data we will run the TradeStation optimization engine on ES 1min price bars from 9/2/2010 to 10/3/2014 with the following optimization ranges for the Least squares Acceleration strategy inputs. I will create 209 30 day in-sample periods each followed by a 7 day out-of-sample period (See Figure 1 for the in-sample/out-of-sample periods).

1. N from 10 to 70 in steps of 10
2. aup from 1 to 3.6 steps of 0.20
3. adn from 1 to 3.6 in steps of 0.20
4. Mult=0.77N<sup>3/2</sup> Note: this normalizes the Acceleration Standard Deviation(SD) for each different lookback period, N, to one standard deviation. Else the Acceleration would have different SDs for different N and it would be difficult to find an aup and adn that worked for all N ranges. See Appendix for a detailed explanation.

This will produce 1372 different input combinations or cases of the strategy input parameters for each of the 209 in-sample/out-of-sample files for the two years of 1min bar ES data.

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

When TS or 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.

Here is an *example* of a better more complicated *filter* that was used in this paper. We require that the number of trades (NT) in the in-sample section be greater or equal to than 10 trades per month. Since there are 21 trading days per month this forces a trade a minimum of half the trading days per month. After using the NT filter, as described, there can still be 100's of rows left in the in-sample section. From experience, it is known that most curve fitted strategy results have high Profit Factors (PF). So for our filter we will restrict the in-sample PF  $\leq 3$ . After using the NT- PF filter, as described, there can still be 100's of rows left in the in-sample section. There is a performance metric called **The Acceleration of The Equity Curve(eq2A)**. Let us choose the 20 rows in the in-sample section that contain the **maximum eq2A** values from the rows that are left from the NT-PF screen. In other words we sort **eq2A** from high to low, eliminate the rows that have **NT** $<10$ , and **PF** $>3$  and then choose the largest **eq2A** 20 Rows of whatever is left. This particular filter will now leave 20 cases or rows in the in-sample file that satisfy the above filter conditions. We call this filter **t20eq2A|p<3|>10** where **t20eq2A** means the top or maximum 20 **eq2A** rows left *after* the NT-PF filter. Suppose for this filter, within the 20 in-sample rows that are left, we want the row that has the highest metric called **The Medium Winning Bars Of All Trades (mWb)** in the in-sample section. We abbreviate this final filter as **t20eq2A|p<3|>10 -mWb**. For each in-sample section this filter leaves only one row in the in-sample section with its associated strategy inputs and out-of-sample net profit in the out-of-sample section using the strategy inputs found in the in-sample section. This particular **t20eq2A|p<3|>10 -mWb filter** is then applied to each of the 209 in-sample sections which give 209 sets of strategy inputs that are used to produce the corresponding 209 out-of-sample performance results. The average out-of-sample performance is calculated from these 209 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 filter combinations that are constructed in a similar manner. Row 3 of the sample output in **Figure 3** shows the results of the filter discussed above.

### **Bootstrap Probability of Filter Results.**

Using modern "Bootstrap" techniques, we can calculate the probability of obtaining our filter's total out-of-sample *net* profits by chance. Here is how the bootstrap technique is applied. Suppose as an example, we have 100 files of in-sample/out-of-sample data. A mirror random filter is created. Instead of picking an out-of-sample net profit (OSNP) from a filter row as before, the mirror filter picks a *random* row's OSNP in each of the 100 files. We repeat this random picking in each of the 100 files 5000 times. Each of the 5000 mirror filters will choose a random row's OSNP of their own in each of the 100 files.. At the end, each of the 5000 mirror filters will have 100 *random* OSNP's picked from the rows of the 100 files. The sum of the 100 random OSNP picks for each mirror filter will generate a random total out-of-sample net profit (tOnpNet) or final random equity. The average and standard deviation of the 5000 mirror filter's different random tOnpNets will allow us to calculate the chance probability of our above chosen filter's tOnpNet. Thus given the mirror filter's bootstrap random tOnpNet average and standard deviation, we can calculate the probability of obtaining our chosen filter's tOnpNet by pure chance alone. **Figure 3** lists the 5000 mirror filter's bootstrap average for our 209 out-of-sample files of **(\$31493)** with a bootstrap standard deviation of **\$11292**. The probability for obtaining our filters net profit of **\$16977** is  **$8.84 \cdot 10^{-6}$**  which is **4.29** standard deviations from the bootstrap

average. For our filter, in row 3 in Figure 3, the expected number of cases that we could obtain by pure chance that would match or exceed the \$31639 is  $23064 \times 8.84 \times 10^{-6} = 0.204$  where 23064 is the total number of different filters we looked at in this run. This number is less than 1, so it is improbable that our result was due to pure chance.

## Results

**Table 1** below presents a table of the 209 in-sample and out-of-sample windows, the **Filter** selected, strategy inputs and the weekly out-of-sample profit/loss results using the filter described above.

**Figure 1** presents a graph of the equity curve generated by using the filter on the 209 weeks ending 10/8/10 – 10/3/14 (note the first month starting 9/2/10 was part of the first 30 day in-sample period). The equity curves is plotted from Equity and Net Equity columns in Table 1. Plotted on the equity curves is the 2<sup>nd</sup> 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 net equity curve with commissions and the green dots are the new highs in net equity.

**Figure 2** presents the out-of-sample 1 minute bar chart of ES for 9/29/14 to 10/2/14 with the LSQA Indicator and all the buy and sell signals for those dates.

## Discussion of Strategy Performance

In Figure 3 Row 3 of the spreadsheet filter output are some statistics that are of interest for our filter. An interesting statistic is **Blw**. Blw is the maximum number of weeks the OSNP equity curve failed to make a new high. Blw is 27 weeks for this filter. This means that 27 weeks was the longest time that the equity for this strategy failed to make a new equity high.

To see the effect of walk forward analysis, take a look at **Table 1**. Notice how the input parameters *N*, *aup*, *adn* 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 lookback period, *N*, has to be higher. During other times when the noise level is not as much *N* can be lower to get onboard a trend faster.

In Figure 1, which presents a graph of the equity curve using the filter on the 209 weeks of out-of-sample data, notice how the equity curve follows the 2<sup>nd</sup> order polynomial trend line with an  $R^2$  of 0.97. This  $R^2$  dropped to 0.92 for the net equity curve.

Using this filter, the strategy was able to generate \$16977 net equity after commissions and slippage of \$20 trading one ES contract for 209 weeks. This period of time from 10/8/10 to 10/3/14 was a volatile market. Yet the LSQA strategy was able to adapt quite well. From Table 1, the largest losing week was -\$2088 on the week ending 6/21/13 a very wild financial time and market week. The largest drawdown was -\$4753 from the week ending on 6/14/13 to 8/9/13.. The drawdown lasted eight weeks and completely recovered and made a new equity high in another sixteen weeks. The longest time between new equity highs was 27 weeks.

In observing Table 1 we can see that this strategy and filter made trades from a low of 0 or no trades/week to a high of 17 trades/week with an average of 3.6 trades/week. For the no trade weeks, the inputs found by the filter in the in-sample section generated no trades in the out-of-sample section.

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

### **Disclaimer**

The strategies, methods and indicators presented here are given for educational purposes only and should not be construed as investment advice. Be aware that the profitable performance presented here is based upon hypothetical trading with the benefit of hindsight and can in no way be assumed nor can it be claimed that the strategy and methods presented here will be profitable in the future or that they will not result in losses

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**Figure 2 Walk Forward Out-Of-Sample Performance Summary  
ES-Mini 1 min bars Least Squares Acceleration Strategy**

ES-1 min bars 9/1/2010 - 10/3/2014 using the below filter on each in-sample segment. The input values *N*, *aup*, and *adn* are the values found from applying the filter to the in-sample sample's optimization run.

**In-sample Section Filter:**  $t20eq2A|p<3|>10-mWb$

Where:

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

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

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

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

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

**NetEq** = running sum of weekly out-of-sample profits minus \$20\*Ont

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

Week #	In-Sample Dates			Out-Of-Sample Dates			osnp	Equity	osnp - \$20*ont	NetEq	ollt	odd	ont	N	aup	adn
1	09/01/10	to	10/01/10	10/04/10	to	10/08/10	(600)	(600)	(640)	(640)	-400	-600	2	40	3.4	1.8
2	09/08/10	to	10/08/10	10/11/10	to	10/15/10	(225)	(825)	(285)	(925)	-163	-225	3	30	3	1.4
3	09/15/10	to	10/15/10	10/18/10	to	10/22/10	100	(725)	40	(885)	-175	-175	3	60	2	2.2
4	09/22/10	to	10/22/10	10/25/10	to	10/29/10	113	(612)	73	(812)	0	0	2	10	3.6	2.2
5	09/29/10	to	10/29/10	11/01/10	to	11/05/10	(575)	(1187)	(675)	(1487)	-550	-1100	5	20	1.6	3
6	10/06/10	to	11/05/10	11/08/10	to	11/12/10	(213)	(1400)	(253)	(1740)	-513	-513	2	40	2.4	2.2
7	10/13/10	to	11/12/10	11/15/10	to	11/19/10	(25)	(1425)	(65)	(1805)	-225	-225	2	40	3.4	2.2
8	10/20/10	to	11/19/10	11/22/10	to	11/26/10	275	(1150)	215	(1590)	-150	-275	3	10	2	3.4
9	10/27/10	to	11/26/10	11/29/10	to	12/03/10	388	(762)	328	(1262)	-250	-250	3	50	2	3.2
10	11/03/10	to	12/03/10	12/06/10	to	12/10/10	388	(374)	368	(894)	0	0	1	40	2.8	3.4
11	11/10/10	to	12/10/10	12/13/10	to	12/17/10		(374)		(894)				40	2.2	3.2
12	11/17/10	to	12/17/10	12/20/10	to	12/24/10		(374)		(894)				40	2.8	2
13	11/24/10	to	12/24/10	12/27/10	to	12/31/10	225	(149)	205	(689)	0	0	1	40	1.4	2
14	12/01/10	to	12/31/10	01/03/11	to	01/07/11	100	(49)	40	(649)	-50	-50	3	10	1.4	1.8
15	12/08/10	to	01/07/11	01/10/11	to	01/14/11	788	739	708	59	0	0	4	10	1.4	2
16	12/15/10	to	01/14/11	01/17/11	to	01/21/11	438	1177	358	417	-113	-113	4	20	2.2	1
17	12/22/10	to	01/21/11	01/24/11	to	01/28/11	488	1665	408	825	-338	-525	4	70	2.2	1
18	12/29/10	to	01/28/11	01/31/11	to	02/04/11	(1263)	402	(1323)	(498)	-513	-1263	3	40	2.6	1.4
19	01/05/11	to	02/04/11	02/07/11	to	02/11/11	613	1015	553	55	-175	-175	3	40	1.8	1.6
20	01/12/11	to	02/11/11	02/14/11	to	02/18/11	350	1365	290	345	-100	-100	3	50	1.4	2.8
21	01/19/11	to	02/18/11	02/21/11	to	02/25/11	(788)	577	(908)	(563)	-888	-1238	6	40	1.6	1.8
22	01/26/11	to	02/25/11	02/28/11	to	03/04/11	(800)	(223)	(900)	(1463)	-825	-1000	5	20	1.4	2.6
23	02/02/11	to	03/04/11	03/07/11	to	03/11/11	(188)	(411)	(288)	(1751)	-538	-925	5	10	3.4	1.8
24	02/09/11	to	03/11/11	03/14/11	to	03/18/11	125	(286)	65	(1686)	-1013	-1013	3	70	2	3.6
25	02/16/11	to	03/18/11	03/21/11	to	03/25/11	63	(223)	43	(1643)	0	0	1	60	3.6	3
26	02/23/11	to	03/25/11	03/28/11	to	04/01/11		(223)		(1643)				60	3.6	2.8
27	03/02/11	to	04/01/11	04/04/11	to	04/08/11		(223)		(1643)				60	3.6	2.8
28	03/09/11	to	04/08/11	04/11/11	to	04/15/11	338	115	318	(1325)	0	0	1	70	2.6	2.6
29	03/16/11	to	04/15/11	04/18/11	to	04/22/11	150	265	110	(1215)	-113	-113	2	40	1.8	3
30	03/23/11	to	04/22/11	04/25/11	to	04/29/11		265		(1215)				40	2.4	2
31	03/30/11	to	04/29/11	05/02/11	to	05/06/11	(675)	(410)	(775)	(1990)	-313	-675	5	40	1.6	2.6
32	04/06/11	to	05/06/11	05/09/11	to	05/13/11	613	203	593	(1397)	0	0	1	50	2.4	2
33	04/13/11	to	05/13/11	05/16/11	to	05/20/11	0	203	(60)	(1457)	-150	-275	3	50	2.4	1.8

Week #	In-Sample Dates			Out-Of-Sample Dates			osnp	Equity	osnp -\$20*ont	NetEq	ollt	odd	ont	N	aup	adn
34	04/20/11	to	05/20/11	05/23/11	to	05/27/11	(163)	40	(223)	(1680)	-100	-163	3	70	2.2	1.8
35	04/27/11	to	05/27/11	05/30/11	to	06/03/11	(1413)	(1373)	(1473)	(3153)	-1038	-1413	3	20	1.8	3.4
36	05/04/11	to	06/03/11	06/06/11	to	06/10/11	13	(1360)	(27)	(3180)	-63	-63	2	70	2.2	2
37	05/11/11	to	06/10/11	06/13/11	to	06/17/11	(88)	(1448)	(228)	(3408)	-238	-575	7	20	2.4	2
38	05/18/11	to	06/17/11	06/20/11	to	06/24/11	(863)	(2311)	(963)	(4371)	-638	-1100	5	30	2.8	2
39	05/25/11	to	06/24/11	06/27/11	to	07/01/11	888	(1423)	848	(3523)	0	0	2	20	2	3.6
40	06/01/11	to	07/01/11	07/04/11	to	07/08/11	150	(1273)	130	(3393)	0	0	1	40	2.2	3.6
41	06/08/11	to	07/08/11	07/11/11	to	07/15/11	(1225)	(2498)	(1325)	(4718)	-488	-1463	5	40	1.6	3.6
42	06/15/11	to	07/15/11	07/18/11	to	07/22/11	(600)	(3098)	(640)	(5358)	-488	-600	2	40	3.4	1.6
43	06/22/11	to	07/22/11	07/25/11	to	07/29/11	1013	(2085)	913	(4445)	-50	-50	5	60	2.8	1.4
44	06/29/11	to	07/29/11	08/01/11	to	08/05/11	2950	865	2670	(1775)	-713	-1288	14	50	3.6	1.6
45	07/06/11	to	08/05/11	08/08/11	to	08/12/11	1788	2653	1448	(327)	-1650	-2338	17	70	3.4	3.2
46	07/13/11	to	08/12/11	08/15/11	to	08/19/11	63	2716	(17)	(344)	-575	-1138	4	50	3.6	3.6
47	07/20/11	to	08/19/11	08/22/11	to	08/26/11	2138	4854	2038	1694	-400	-650	5	50	3.6	3.6
48	07/27/11	to	08/26/11	08/29/11	to	09/02/11	(150)	4704	(250)	1444	-575	-575	5	50	3.6	3.6
49	08/03/11	to	09/02/11	09/05/11	to	09/09/11	(763)	3941	(823)	621	-950	-1625	3	50	3.6	3.6
50	08/10/11	to	09/09/11	09/12/11	to	09/16/11	325	4266	225	846	-288	-363	5	60	3.2	3.2
51	08/17/11	to	09/16/11	09/19/11	to	09/23/11	(825)	3441	(965)	(119)	-1188	-1763	7	40	2.4	3.6
52	08/24/11	to	09/23/11	09/26/11	to	09/30/11	2825	6266	2705	2586	-475	-475	6	40	2.6	3.4
53	08/31/11	to	09/30/11	10/03/11	to	10/07/11	2200	8466	1980	4566	-625	-1613	11	40	3.6	2.6
54	09/07/11	to	10/07/11	10/10/11	to	10/14/11	(913)	7553	(953)	3613	-625	-913	2	40	3.6	3.4
55	09/14/11	to	10/14/11	10/17/11	to	10/21/11	675	8228	595	4208	-313	-813	4	40	3.4	3.6
56	09/21/11	to	10/21/11	10/24/11	to	10/28/11	175	8403	95	4303	-763	-763	4	40	3.4	3.4
57	09/28/11	to	10/28/11	10/31/11	to	11/04/11	38	8441	(82)	4221	-925	-1400	6	30	1.6	3.6
58	10/05/11	to	11/04/11	11/07/11	to	11/11/11	(1150)	7291	(1210)	3011	-688	-1150	3	50	3.2	2.4
59	10/12/11	to	11/11/11	11/14/11	to	11/18/11	(63)	7228	(163)	2848	-513	-988	5	50	3.6	2
60	10/19/11	to	11/18/11	11/21/11	to	11/25/11	75	7303	55	2903	0	0	1	60	3.4	3
61	10/26/11	to	11/25/11	11/28/11	to	12/02/11	(475)	6828	(515)	2388	-575	-575	2	60	3.2	3
62	11/02/11	to	12/02/11	12/05/11	to	12/09/11	200	7028	140	2528	0	0	3	30	3.6	2.2
63	11/09/11	to	12/09/11	12/12/11	to	12/16/11	1488	8516	1428	3956	-25	-25	3	40	3	2.4
64	11/16/11	to	12/16/11	12/19/11	to	12/23/11	(488)	8028	(508)	3448	0	0	1	40	3.6	2.8
65	11/23/11	to	12/23/11	12/26/11	to	12/30/11		8028		3448				50	3	2.2
66	11/30/11	to	12/30/11	01/02/12	to	01/06/12	1000	9028	940	4388	0	0	3	40	2	2.8
67	12/07/11	to	01/06/12	01/09/12	to	01/13/12	288	9316	248	4636	0	0	2	40	2	3.6
68	12/14/11	to	01/13/12	01/16/12	to	01/20/12	263	9579	243	4879	0	0	1	60	1.8	2
69	12/21/11	to	01/20/12	01/23/12	to	01/27/12	1688	11267	1628	6507	0	0	3	50	1.6	1.6
70	12/28/11	to	01/27/12	01/30/12	to	02/03/12	375	11642	295	6802	-213	-300	4	50	3	1.6
71	01/04/12	to	02/03/12	02/06/12	to	02/10/12		11642		6802				50	3.2	1.6
72	01/11/12	to	02/10/12	02/13/12	to	02/17/12	(75)	11567	(115)	6687	-75	-75	2	40	3.2	1.6
73	01/18/12	to	02/17/12	02/20/12	to	02/24/12	50	11617	30	6717	0	0	1	10	3	1.8
74	01/25/12	to	02/24/12	02/27/12	to	03/02/12	(350)	11267	(430)	6287	-500	-600	4	10	1.8	2.4
75	02/01/12	to	03/02/12	03/05/12	to	03/09/12	(988)	10279	(1068)	5219	-325	-988	4	50	2.8	1.4
76	02/08/12	to	03/09/12	03/12/12	to	03/16/12	(1038)	9241	(1098)	4121	-963	-1038	3	40	2.8	1.4
77	02/15/12	to	03/16/12	03/19/12	to	03/23/12	250	9491	190	4311	-150	-200	3	10	1.8	3
78	02/22/12	to	03/23/12	03/26/12	to	03/30/12	450	9941	390	4701	0	0	3	10	1.8	3.6
79	02/29/12	to	03/30/12	04/02/12	to	04/06/12	113	10054	53	4754	-200	-200	3	40	1.6	3.6
80	03/07/12	to	04/06/12	04/09/12	to	04/13/12	938	10992	818	5572	-588	-588	6	70	2.6	1.2
81	03/14/12	to	04/13/12	04/16/12	to	04/20/12	188	11180	88	5660	-588	-738	5	40	3	1.6
82	03/21/12	to	04/20/12	04/23/12	to	04/27/12	188	11368	148	5808	-63	-63	2	40	3.4	1.6
83	03/28/12	to	04/27/12	04/30/12	to	05/04/12	438	11806	398	6206	0	0	2	40	2.6	1.8
84	04/04/12	to	05/04/12	05/07/12	to	05/11/12	463	12269	423	6629	0	0	2	50	3.4	1.8
85	04/11/12	to	05/11/12	05/14/12	to	05/18/12	(1000)	11269	(1040)	5589	-925	-1000	2	50	2.4	2.2
86	04/18/12	to	05/18/12	05/21/12	to	05/25/12	(488)	10781	(588)	5001	-463	-750	5	20	3.6	1.4
87	04/25/12	to	05/25/12	05/28/12	to	06/01/12	13	10794	(67)	4934	-363	-650	4	10	3.4	2.4

Week #	In-Sample Dates			Out-Of-Sample Dates			osnp	Equity	osnp -\$20*ont	NetEq	ollt	odd	ont	N	aup	adn
88	05/02/12	to	06/01/12	06/04/12	to	06/08/12	(250)	10544	(310)	4624	-513	-513	3	10	2.4	3.6
89	05/09/12	to	06/08/12	06/11/12	to	06/15/12	275	10819	215	4839	-188	-363	3	50	2	3.6
90	05/16/12	to	06/15/12	06/18/12	to	06/22/12	(63)	10756	(83)	4756	0	0	1	50	2.4	2.8
91	05/23/12	to	06/22/12	06/25/12	to	06/29/12	(625)	10131	(685)	4071	-575	-625	3	50	3	2.8
92	05/30/12	to	06/29/12	07/02/12	to	07/06/12	(325)	9806	(345)	3726	0	0	1	70	3.6	2.2
93	06/06/12	to	07/06/12	07/09/12	to	07/13/12	(100)	9706	(120)	3606	0	0	1	30	2.2	3.6
94	06/13/12	to	07/13/12	07/16/12	to	07/20/12	(325)	9381	(345)	3261	0	0	1	40	3.2	2.8
95	06/20/12	to	07/20/12	07/23/12	to	07/27/12	500	9881	400	3661	-63	-100	5	40	2.2	2.8
96	06/27/12	to	07/27/12	07/30/12	to	08/03/12	(350)	9531	(390)	3271	-200	-350	2	40	3.6	2.4
97	07/04/12	to	08/03/12	08/06/12	to	08/10/12		9531		3271				70	3.6	2.2
98	07/11/12	to	08/10/12	08/13/12	to	08/17/12		9531		3271				60	3.6	2.2
99	07/18/12	to	08/17/12	08/20/12	to	08/24/12	88	9619	28	3299	-238	-388	3	40	2.2	1.4
100	07/25/12	to	08/24/12	08/27/12	to	08/31/12	(238)	9381	(318)	2981	-138	-238	4	50	2.2	1.6
101	08/01/12	to	08/31/12	09/03/12	to	09/07/12	713	10094	633	3614	-13	-13	4	30	1.2	2.8
102	08/08/12	to	09/07/12	09/10/12	to	09/14/12	613	10707	553	4167	-138	-138	3	30	1.2	2.8
103	08/15/12	to	09/14/12	09/17/12	to	09/21/12	338	11045	278	4445	-75	-75	3	30	1.2	2.8
104	08/22/12	to	09/21/12	09/24/12	to	09/28/12	175	11220	95	4540	-175	-175	4	60	1.4	3
105	08/29/12	to	09/28/12	10/01/12	to	10/05/12	525	11745	445	4985	-138	-138	4	40	2	2.6
106	09/05/12	to	10/05/12	10/08/12	to	10/12/12	338	12083	318	5303	0	0	1	40	2.6	2.2
107	09/12/12	to	10/12/12	10/15/12	to	10/19/12	(225)	11858	(245)	5058	0	0	1	50	3	1.6
108	09/19/12	to	10/19/12	10/22/12	to	10/26/12	438	12296	338	5396	-88	-88	5	40	3	1.8
109	09/26/12	to	10/26/12	10/29/12	to	11/02/12		12296		5396				40	2.4	2.4
110	10/03/12	to	11/02/12	11/05/12	to	11/09/12	(1338)	10958	(1398)	3998	-688	-1338	3	40	1.6	3.4
111	10/10/12	to	11/09/12	11/12/12	to	11/16/12	2075	13033	1915	5913	-275	-350	8	40	2.8	1.6
112	10/17/12	to	11/16/12	11/19/12	to	11/23/12	(150)	12883	(190)	5723	-325	-325	2	40	2	2.6
113	10/24/12	to	11/23/12	11/26/12	to	11/30/12	1238	14121	1138	6861	-150	-150	5	60	1.6	3
114	10/31/12	to	11/30/12	12/03/12	to	12/07/12	738	14859	698	7559	0	0	2	40	2	3.2
115	11/07/12	to	12/07/12	12/10/12	to	12/14/12		14859		7559				30	1.8	2.8
116	11/14/12	to	12/14/12	12/17/12	to	12/21/12	113	14972	93	7652	0	0	1	40	2	2.8
117	11/21/12	to	12/21/12	12/24/12	to	12/28/12	525	15497	465	8117	0	0	3	60	3.6	1
118	11/28/12	to	12/28/12	12/31/12	to	01/04/13	700	16197	620	8737	-113	-113	4	20	1.8	3.4
119	12/05/12	to	01/04/13	01/07/13	to	01/11/13	100	16297	80	8817	0	0	1	60	1.4	2.8
120	12/12/12	to	01/11/13	01/14/13	to	01/18/13	238	16535	198	9015	0	0	2	20	1.2	3.4
121	12/19/12	to	01/18/13	01/21/13	to	01/25/13	138	16673	118	9133	0	0	1	20	1.6	3.4
122	12/26/12	to	01/25/13	01/28/13	to	02/01/13	(425)	16248	(485)	8648	-300	-513	3	60	1	2
123	01/02/13	to	02/01/13	02/04/13	to	02/08/13		16248		8648				30	1.8	1.4
124	01/09/13	to	02/08/13	02/11/13	to	02/15/13	(225)	16023	(265)	8383	-175	-225	2	20	2.2	1.2
125	01/16/13	to	02/15/13	02/18/13	to	02/22/13	38	16061	(22)	8361	-250	-250	3	30	1.6	1.4
126	01/23/13	to	02/22/13	02/25/13	to	03/01/13	975	17036	715	9076	-588	-850	13	20	2.2	1.4
127	01/30/13	to	03/01/13	03/04/13	to	03/08/13	(263)	16773	(323)	8753	-200	-263	3	40	2.6	1.6
128	02/06/13	to	03/08/13	03/11/13	to	03/15/13	138	16911	118	8871	0	0	1	40	1.2	3
129	02/13/13	to	03/15/13	03/18/13	to	03/22/13	(63)	16848	(183)	8688	-388	-638	6	40	1.2	3
130	02/20/13	to	03/22/13	03/25/13	to	03/29/13	325	17173	285	8973	-88	-88	2	40	1.4	3.6
131	02/27/13	to	03/29/13	04/01/13	to	04/05/13	1500	18673	1400	10373	0	0	5	50	3.2	1.2
132	03/06/13	to	04/05/13	04/08/13	to	04/12/13	(350)	18323	(370)	10003	0	0	1	60	2.8	1.6
133	03/13/13	to	04/12/13	04/15/13	to	04/19/13	(375)	17948	(495)	9508	-463	-1363	6	60	2.8	1.6
134	03/20/13	to	04/19/13	04/22/13	to	04/26/13	(263)	17685	(283)	9225	0	0	1	50	2	2.2
135	03/27/13	to	04/26/13	04/29/13	to	05/03/13	463	18148	403	9628	0	0	3	70	1.6	2.6
136	04/03/13	to	05/03/13	05/06/13	to	05/10/13	(100)	18048	(120)	9508	0	0	1	70	1.8	2.6
137	04/10/13	to	05/10/13	05/13/13	to	05/17/13	113	18161	93	9601	0	0	1	40	2	3
138	04/17/13	to	05/17/13	05/20/13	to	05/24/13	(450)	17711	(590)	9011	-1000	-1000	7	40	2.6	1.6
139	04/24/13	to	05/24/13	05/27/13	to	05/31/13	1413	19124	1313	10324	-100	-175	5	40	2.8	1.8
140	05/01/13	to	05/31/13	06/03/13	to	06/07/13	113	19237	13	10337	-588	-888	5	40	3.6	1.4
141	05/08/13	to	06/07/13	06/10/13	to	06/14/13	1688	20925	1608	11945	-125	-175	4	70	2	2.8

Week #	In-Sample Dates			Out-Of-Sample Dates			osnp	Equity	osnp -\$20*ont	NetEq	ollt	odd	ont	N	aup	adn
142	05/15/13	to	06/14/13	06/17/13	to	06/21/13	(2088)	18837	(2248)	9697	-1338	-2913	8	60	2.2	3.2
143	05/22/13	to	06/21/13	06/24/13	to	06/28/13	(1225)	17612	(1325)	8372	-550	-1375	5	70	3.6	2.2
144	05/29/13	to	06/28/13	07/01/13	to	07/05/13		17612		8372				20	2.8	3.4
145	06/05/13	to	07/05/13	07/08/13	to	07/12/13		17612		8372				30	3.2	2.4
146	06/12/13	to	07/12/13	07/15/13	to	07/19/13		17612		8372				20	2.8	3.2
147	06/19/13	to	07/19/13	07/22/13	to	07/26/13		17612		8372				60	3.2	2.6
148	06/26/13	to	07/26/13	07/29/13	to	08/02/13	(788)	16824	(828)	7544	-500	-788	2	40	1.6	3.6
149	07/03/13	to	08/02/13	08/05/13	to	08/09/13	(50)	16774	(110)	7434	-213	-213	3	40	2.6	1.4
150	07/10/13	to	08/09/13	08/12/13	to	08/16/13	200	16974	120	7554	-175	-250	4	60	1.4	2.4
151	07/17/13	to	08/16/13	08/19/13	to	08/23/13	650	17624	530	8084	-438	-575	6	20	3	1.8
152	07/24/13	to	08/23/13	08/26/13	to	08/30/13	663	18287	523	8607	-163	-213	7	20	2.4	2
153	07/31/13	to	08/30/13	09/02/13	to	09/06/13	1013	19300	933	9540	-125	-125	4	50	3.2	1.8
154	08/07/13	to	09/06/13	09/09/13	to	09/13/13		19300		9540				70	2	2.4
155	08/14/13	to	09/13/13	09/16/13	to	09/20/13	613	19913	553	10093	-50	-50	3	70	1.6	3.4
156	08/21/13	to	09/20/13	09/23/13	to	09/27/13		19913		10093				40	2.8	2
157	08/28/13	to	09/27/13	09/30/13	to	10/04/13	925	20838	705	10798	-400	-475	11	20	1.8	2.2
158	09/04/13	to	10/04/13	10/07/13	to	10/11/13	200	21038	120	10918	-275	-275	4	60	2	3.2
159	09/11/13	to	10/11/13	10/14/13	to	10/18/13	25	21063	(115)	10803	-238	-338	7	10	3.4	2
160	09/18/13	to	10/18/13	10/21/13	to	10/25/13	138	21201	98	10901	0	0	2	40	1.6	2.6
161	09/25/13	to	10/25/13	10/28/13	to	11/01/13	88	21289	(52)	10849	-188	-188	7	10	2.4	3.2
162	10/02/13	to	11/01/13	11/04/13	to	11/08/13	75	21364	35	10884	-838	-838	2	30	1.6	3.6
163	10/09/13	to	11/08/13	11/11/13	to	11/15/13		21364		10884				50	3	2
164	10/16/13	to	11/15/13	11/18/13	to	11/22/13	913	22277	853	11737	0	0	3	40	3.4	1.6
165	10/23/13	to	11/22/13	11/25/13	to	11/29/13	(38)	22239	(78)	11659	-25	-38	2	60	3	1.4
166	10/30/13	to	11/29/13	12/02/13	to	12/06/13	38	22277	(42)	11617	-225	-225	4	40	2.6	1.8
167	11/06/13	to	12/06/13	12/09/13	to	12/13/13	(38)	22239	(78)	11539	-138	-138	2	30	2.8	1.4
168	11/13/13	to	12/13/13	12/16/13	to	12/20/13	1138	23377	1078	12617	-188	-188	3	50	1.4	3.2
169	11/20/13	to	12/20/13	12/23/13	to	12/27/13		23377		12617				70	1.2	3.4
170	11/27/13	to	12/27/13	12/30/13	to	01/03/14	(300)	23077	(320)	12297	0	0	1	70	1.2	3.4
171	12/04/13	to	01/03/14	01/06/14	to	01/10/14	150	23227	50	12347	-325	-463	5	70	1.2	3.4
172	12/11/13	to	01/10/14	01/13/14	to	01/17/14	550	23777	510	12857	-75	-75	2	30	2.2	2.2
173	12/18/13	to	01/17/14	01/20/14	to	01/24/14	(475)	23302	(615)	12242	-675	-1513	7	40	1.8	1.6
174	12/25/13	to	01/24/14	01/27/14	to	01/31/14	100	23402	(140)	12102	-313	-425	12	30	2.4	1.8
175	01/01/14	to	01/31/14	02/03/14	to	02/07/14	(600)	22802	(740)	11362	-588	-1275	7	40	3.6	2.6
176	01/08/14	to	02/07/14	02/10/14	to	02/14/14	713	23515	693	12055	0	0	1	50	3.4	2.6
177	01/15/14	to	02/14/14	02/17/14	to	02/21/14		23515		12055				50	2.8	3.6
178	01/22/14	to	02/21/14	02/24/14	to	02/28/14	(88)	23427	(108)	11947	0	0	1	50	3.4	2.6
179	01/29/14	to	02/28/14	03/03/14	to	03/07/14	(63)	23364	(103)	11844	-100	-100	2	30	2	3.2
180	02/05/14	to	03/07/14	03/10/14	to	03/14/14	1800	25164	1720	13564	-275	-275	4	40	2.8	1.8
181	02/12/14	to	03/14/14	03/17/14	to	03/21/14	1138	26302	1018	14582	-263	-263	6	40	3.6	2.2
182	02/19/14	to	03/21/14	03/24/14	to	03/28/14	1275	27577	1175	15757	-150	-150	5	40	3.6	2.4
183	02/26/14	to	03/28/14	03/31/14	to	04/04/14	(1500)	26077	(1540)	14217	-1513	-1513	2	40	2.8	3
184	03/05/14	to	04/04/14	04/07/14	to	04/11/14	(463)	25614	(583)	13634	-850	-850	6	40	2.6	2.6
185	03/12/14	to	04/11/14	04/14/14	to	04/18/14	(75)	25539	(95)	13539	0	0	1	30	3.6	2.2
186	03/19/14	to	04/18/14	04/21/14	to	04/25/14	213	25752	193	13732	0	0	1	30	3.6	1.6
187	03/26/14	to	04/25/14	04/28/14	to	05/02/14	(25)	25727	(125)	13607	-275	-275	5	20	2	3.6
188	04/02/14	to	05/02/14	05/05/14	to	05/09/14	1300	27027	1240	14847	0	0	3	20	2.2	3.6
189	04/09/14	to	05/09/14	05/12/14	to	05/16/14	550	27577	510	15357	0	0	2	20	2.4	3.6
190	04/16/14	to	05/16/14	05/19/14	to	05/23/14	(263)	27314	(303)	15054	-250	-263	2	70	2	2.8
191	04/23/14	to	05/23/14	05/26/14	to	05/30/14		27314		15054				50	2.2	2.8
192	04/30/14	to	05/30/14	06/02/14	to	06/06/14	1025	28339	985	16039	0	0	2	20	1.6	3.2
193	05/07/14	to	06/06/14	06/09/14	to	06/13/14	175	28514	135	16174	0	0	2	10	2.2	3
194	05/14/14	to	06/13/14	06/16/14	to	06/20/14		28514		16174				20	2.2	2
195	05/21/14	to	06/20/14	06/23/14	to	06/27/14	313	28827	253	16427	-88	-150	3	60	1.6	1.8

Week #	In-Sample Dates			Out-Of-Sample Dates			osnp	Equity	osnp - \$20*ont	NetEq	ollt	odd	ont	N	aup	adn
196	05/28/14	to	06/27/14	06/30/14	to	07/04/14	(200)	28627	(220)	16207	0	0	1	50	2	1.6
197	06/04/14	to	07/04/14	07/07/14	to	07/11/14	(138)	28489	(198)	16009	-325	-500	3	60	2.2	1.4
198	06/11/14	to	07/11/14	07/14/14	to	07/18/14	225	28714	125	16134	-700	-700	5	70	3.2	1.4
199	06/18/14	to	07/18/14	07/21/14	to	07/25/14	(38)	28676	(58)	16076	0	0	1	40	3.4	1.6
200	06/25/14	to	07/25/14	07/28/14	to	08/01/14	(150)	28526	(270)	15806	-750	-788	6	60	3.6	1.4
201	07/02/14	to	08/01/14	08/04/14	to	08/08/14	963	29489	883	16689	-200	-200	4	40	3	2
202	07/09/14	to	08/08/14	08/11/14	to	08/15/14	(213)	29276	(273)	16416	-250	-400	3	10	3	3.6
203	07/16/14	to	08/15/14	08/18/14	to	08/22/14		29276		16416				40	2.6	2.6
204	07/23/14	to	08/22/14	08/25/14	to	08/29/14	13	29289	(7)	16409	0	0	1	70	2.6	2
205	07/30/14	to	08/29/14	09/01/14	to	09/05/14	200	29489	180	16589	0	0	1	70	2.6	2
206	08/06/14	to	09/05/14	09/08/14	to	09/12/14	263	29752	203	16792	-325	-325	3	70	1.8	2
207	08/13/14	to	09/12/14	09/15/14	to	09/19/14	375	30127	275	17067	-263	-388	5	40	1.6	3.4
208	08/20/14	to	09/19/14	09/22/14	to	09/26/14	(1063)	29064	(1143)	15924	-525	-1425	4	40	2	2.2
209	08/27/14	to	09/26/14	09/29/14	to	10/03/14	1213	30277	1053	16977	-163	-300	8	70	2.6	1.6

Where:

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

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

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

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

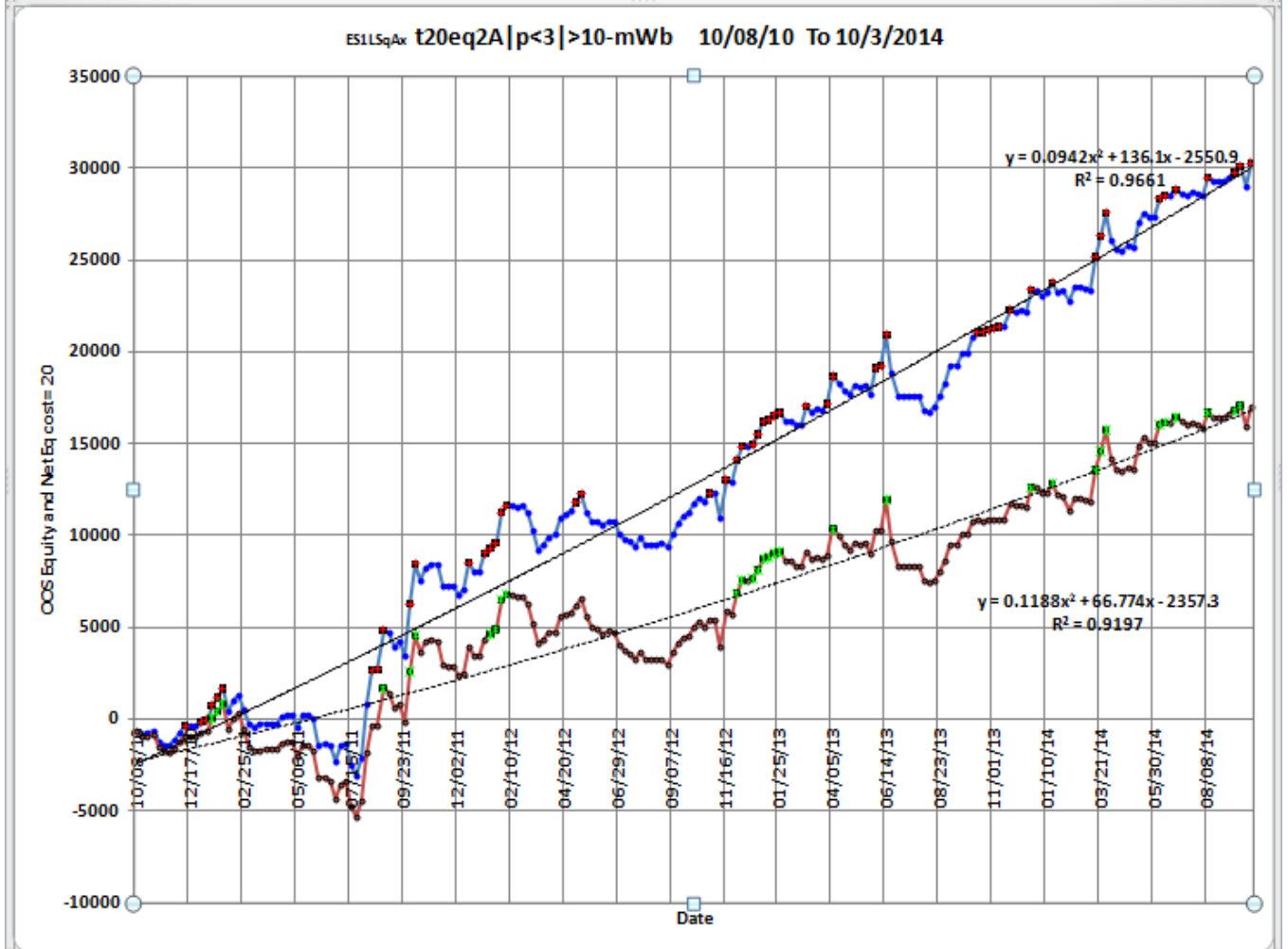
**Equity** = running sum of the weekly out-of-sample profits(Osnp)

**NetEq** = running sum of weekly out-of-sample profits minus \$20\*Ont

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

**Figure 1 Graph of Least Squares Acceleration Strategy Net Equity Applying the Walk Forward Filter Each Week On ES 1min Bar Prices 10/8/2010 to 10/3/2014**

Note: The blue line is the equity curve without commissions and the red dots on the blue line are new highs in equity. The brown line is the equity curve with commissions and the green dots are the new highs in net equity.



**Figure 2 Walk Forward Out-Of-Sample Performance Summary for ES1 Least Squares Acceleration Strategy**  
**1 minute bar chart from 9/29/14-10/3/2014**





**Figure 3** Partial output of the Walk Forward Metric Performance Explorer (WFME)  
ES-Mini 1 min bars Least Squares Acceleration Strategy

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	ES1LsqAx	s10/08/10	e10/03/14	#209	AnyTnp				a[31493]	s11292	f23064									c=\$20	
2	Filter-Metric	tOnp	aOnp	aOTrd	aO#T	B0	%P	t	std	LLp	eqDD	lr	#	eqTrn	eqV^3	eqR2	Dev^2	Blw	BE	tOnpNet	Prob
3	t20eq2A p<3 >10-mWb	30277	164	45.5	3.6	0.8	61	2.96	751	-2088	-4763	5	185	156	201	97	1789	27	84.3	16977	8.84E-06
4	t20eq2A p<4 >10-mWb	29540	159	43.8	3.6	1.2	61	2.84	762	-2088	-6188	5	186	146	256	95	2077	29	92.2	16060	1.27E-05
5	t20mWTr p<3-tnp	28179	179	45.1	4	(2.3)	57	2.86	787	-2738	-3263	6	157	135	75	88	3058	37	76.8	15679	1.47E-05
6	t20eq2V p<3 >10-mWb	30909	162	37.8	4.3	1.3	59	3.18	704	-2088	-3026	6	191	158	249	95	2163	32	75.7	14569	2.26E-05
7	t20mLb >10-eq2A	29593	156	38.9	4	2.1	58	2.57	835	-2088	-5340	5	190	141	372	89	3053	42	114.9	14393	2.42E-05
8	t20mWTr p<4-tnp	25950	165	43.3	3.8	(0.5)	54	2.63	788	-1900	-3777	7	157	129	159	93	2221	37	90.8	13970	2.84E-05
9	t50eq2A p<3 >10-mKr	28294	155	38.9	4	1.0	57	2.97	706	-1488	-3115	5	182	131	260	97	1481	29	82.5	13734	3.10E-05

The WFME Filter Output Columns are defined as follows:

**Row 1** ES1LsqAx is the strategy abbreviation, First OOS Week End Date(10/8/110), Last OOS Week End Date(10/3/14), **Number of weeks(#209)** a=average of bootstrap random picks. s= standard deviation of bootstrap random picks. f=number of different filters examined. c= slippage and round trip trade cost(c=\$20).

**Filter** = The filter that was run. Row 3 filter **t20eq2A|p<3|>10-mWb**

The **t20eq2A|p<3|>10-mWb** filter produced the following average 209 week statistics on row 3.

**tOnp** = Total out-of-sample(oos) net profit for these 209 weeks.

**aOsp** = Average oos net profit for the 209 weeks

**aOTrd** = Average oos profit per trade

**aO#T** = Average number of oos trades per week

**B0** = The 209 week trend of the out-of-sample weekly profits

**%P** = The percentage of oos weeks that were profitable

**t** = The student t statistic for the 209 weekly oos profits. The higher the t statistic the higher the probability that this result was not due to pure chance

**std** = The standard deviation of the 209 weekly oos profits

**llp** = The largest losing oos period(week)

**eqDD** = The oos equity drawdown

**lr** = The largest number of losing oos weeks in a row

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

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

**eqV^3** = The ending velocity of 3<sup>rd</sup> order polynomial that is fit to the equity curve

**Eq2A** = The correlation coefficient( $r^2$ ) of a straight line fit to the equity curve



**Dev<sup>2</sup>** = A measure of equity curve smoothness. The square root of the average [(equity curve minus a straight line)<sup>2</sup>]

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

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

**tOnpNet** = Total out-of-sample net profit(tOnpNet) minus the total trade cost.  
$$tOnpNet = tOnp - (\text{Number of trade weeks}) * aOnT * \text{Cost}.$$

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

## Appendix: The Normalization Multiplier

### What is the Multiplier ?

The Least Square Acceleration, is the least square fit of a of a 2nd order polynomial to a set of prices. One of the inputs to the calculation of acceleration is **N**, the number of lookback bars. When we plot the acceleration of a price series over many bars we notice that the amplitude, and the maximum and minimum values of the acceleration vary quite significantly with different **N** inputs.

Below is a table of the standard deviation of the 416339 calculated Acceleration values of ES1min bars for different **N**. We used 1 min bars of the E-Mini from 9/2/2010 to 10/3/2014 to generate this table.

#### ES 1 min bars Date Range

**8/30/2010 to 10/3/2014**

**Total Number of Bars=416339**

N	SD	1/SD
10	0.0441255	22.6626
20	0.0147781	67.6678
30	0.0078451	127.468
40	0.00502987	198.812
50	0.00359628	278.065
60	0.00273494	365.639
70	0.00216985	460.861

As we can see the Standard Deviation of the acceleration for **N=10** is approximately 20 times the SD for **N=70**. This means the Acceleration range for **N=10** is approximately 20 times the Acceleration range of **N=70**. This makes it difficult to find a set of aup and adn that satisfy all **N**. We would like to find a multiplier of the Acceleration that normalizes all the **N** SDs and ranges to the same ranges.

Fortunately the SDs for the different **Ns** for a Least Squares Acceleration are proportional to  $N^{3/2}$ . So if we multiply the Acceleration by the  $N^{3/2}$ , the acceleration for different **N** should have the same SDs and ranges. Below are the results for multiplying the Acceleration by  $N^{3/2}$ .

ES 1 min bars Date Range 8/30/2010 to 10/3/2014. Total Number of Bars=416339,  $N^{3/2}$

LSqAcceleration Multiplier to Scale Acceleration N Range to One SD

N	SD	1/SD
10	1.39537	0.716655
20	1.32179	0.756549
30	1.28908	0.775746
40	1.27247	0.785874
50	1.27148	0.786487
60	1.27108	0.78673
70	1.2708	0.786906
Avg	1.298867	0.770707

As we can see the SDs are now very close. If we multiply all calculated accelerations by  $0.770707 N^{3/2}$  then the SDs of the accelerations for all will be normalized to 1. This allows us to

do an optimization search for ranges of  $\text{aup}$  and  $\text{adn}$  from 0.2 to 3.6 standard deviations for all N.