Trading the 24hr Euro 1 min bar Futures With The Least Squares Velocity Strategy Part 3 4/1/2010 -4/27/2018

Working Paper May, 2018

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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

In our working paper, http://meyersanalytics.com/publications2/EC1LSqVx-2.pdf, we examined a trading system for the Euro 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 with the Least Squares Velocity Strategy applied to the EC 1min price bars from 4/1/2010 to 4/28/2017. In this paper we will examine how that metric combination filter did in the 52 weeks following 4/28/2017from 5/5/2017 to 4/27/2018

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.

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

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

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:

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 = 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.

Discussion of Euro Futures Prices
The Euro (EC) is traded on Globex. On Globex the EC is traded on a 23hour basis ..On Monday Through Thursday the EC closes at 1600hr CST and reopens at 1700hr CST. On Friday the EC closes at 1600hr CST and reopens on Sunday at 1700hr CST For this paper we will trade all hours that Globex is open but we will close all open positions on Friday at 1600hr CST and resume trading at 1700hr on Sunday. Please note that the strategy might not have a buy or sell signal when trading opens on Sunday. To test this strategy we will use 1-minute bar prices of the EC futures contract for the 7 years from April 1, 2010 to April 28, 2017. We will use the 52 weeks of EC 1min bar prices following 4/28/2017, from 5/5/2017 to 4/27/2018, to see how the Least Squares Velocity strategy out-of-sample metric filter found on the 4/1/2010 to 4/28/2017 price data performed on ***future*** data it had not seen.

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 EC 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 loses when traded in real time from something that looked great in the in-sample section.

In order to gain confidence that our input parameter selection method using the optimization output of the in-sample data will produce profits, we must test the input parameters we found in the in-sample section on out-of-sample data. In addition, we must perform the in-sample/out-of-sample analysis many times. Why not just do the out-of-sample analysis once or just 10 times? Well just as in Poker or any card game, where there is considerable variation in luck from hand to hand, walk forward out-of-sample analysis give considerable variation in 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 **EC** 1min price bars from 4/1/2010 to 4/27/2018 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 Figure 1 for the in-sample/out-of-sample periods). I will use the following strategy input optimization ranges.

1. N from 20 to 70 in steps of 10
2 vup from 0.2 to 3.6 steps of 0.2
3 vdn from 0.2 to 3.6 in steps of 0.2
4 Mult=4355*√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.

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This will produce 1944 different input combinations or cases of the strategy input parameters for each of the 364 in-sample/out-of-sample files for the 7 years of 1 min bar EC prices from 4/1/2010 to 4/28/2017.

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.

Here is the more complicated ***filter*** found by the WFME65 v8x program that was used on the in-sample sections of the previous working paper as well as this paper. **R2** is defined as the in-sample trade equity regression trend line coefficient of correlation $\mathbf{r^2}$. $\mathbf{r^2}$ is a measure of how well a straight line fits the equity curve generated by a set of in-sample strategy inputs. High **r2** values in the in-sample section usually mean poor performance in the out-of-sample-section. This is a kind of reversion to the mean and a measure of how well the price noise is being fitted in the **IS** section. So, in the in-sample section we eliminate all strategy input rows that have a **r2>80**. After using the **r2** filter, as described, there can still be 100's of rows left in the in-sample section. Few traders can stay with a strategy that has a large number of losing trades in a row (**lr**). For this filter we will limit the number losing trades in a row in the 30 day IS period to 3 or less (**lr<3**). We would also like there to be at least 5 trades per in-sample section (**nt>5**). The PWFO generates the metric **mLTr.** This is the median of the losing trade losses in the in-sample section. We take the median of all the losing trades to minimize the effect of large losing trades that may be outliers that are not repeatable. Let us choose the 50 rows that contain the least negative **mLTr** values from the rows that are left from the **lr-r2** elimination. This filter will now leave 50 cases or rows in the in-sample section that satisfy the above filter conditions. Suppose for this filter, within the 50 in-sample rows that are left, we want the row that has the minimum PWFO metric **mDev** in the in-sample section**.** This metric is the median of all the

absolute values of the deviations of the equity curve from the straight line fit to the equity curve. This would produce a filter named **t50mLTr|lr<5r2<80nt>5-mDev.** This in-sample filter leaves only one row in the PWFO in-sample section with its associated strategy inputs and out-of-sample net profit in the out-of-sample section. The **t50mLTr|lr<5r2<80nt>5-mDev.** filter finds the strategy inputs parameters in each of the 364 in-sample sections and applies these inputs to the out-of-sample section. Using the filter in-sample strategy inputs on the 364 out-of-sample sections, the average out-of-sample performance is calculated. In addition, many other important out-of-sample performance statistics for this filter are calculated and summarized. **Figure 3** shows such a filter computer run along with a small sample of other filter combinations that are constructed in a similar manner and how these filters did in the following 52 weeks since 4/28/17. **Row 6** of the sample output in **Figure 3** shows the results of the filter discussed above that was used in our previous paper for the week ending dates of 5/14/10 to 4/28/17 and what happened if we would have used this filter for the 52 weeks from 4/28/17 to 4/27/18. Commissions and slippage for the EC were estimated at $30 round trip for one contract. A total of 30752 different metric filters were examined. More on this below on how that number of filters combinations effect the probability that the filter chosen was or was not due to chance.

Bootstrap Probability of Filter Results.

Using modern "Bootstrap" techniques, we can calculate the probability of obtaining our filter's total out-of-sample ***net*** profits by chance. Here'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 500 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 364 out-of-sample files of **($417.4)** with a bootstrap standard deviation of **$105.1**. (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/364) and 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 **$2.77x10^{-13}$** 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- $2.77x10^{-13}$)^30752 ~= 30752 x $2.77x10^{-13}$ ~= 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

Results

Table 1 below presents a table of the 364 and the 52 future weeks 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 364 weeks ending 5/14/2010 – 4/28/2017 and the equity curve on the 52 weeks following until 4/27/2018 (note the first month starting 4/1/2010 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 EC weekly closing prices superimposed on the Equity Chart. The vertical dotted red line on the right separates the future excluded period equity from 5/05/17 to 4/27/18. This is what would have happened if you used the **t50mLTr|lr<5r2<80nt>5-mDev** filter found in the previous paper on future data not included in the 4/1/2010-4/28/2017 run.

Figure 2 presents the out-of-sample 1-minute bar chart of EC for 4/23/18 to 4/27/18 with the LSQV Indicator and all the buy and sell signals for those dates.

Discussion of Strategy Performance

In **Figure 3, Row 6** is the filter chosen in the previous paper, **t50mLTr|lr<5r2<80nt>5-mDev** . 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 36 weeks for this filter. This means that 36 weeks was the longest time that the equity for this strategy failed to make a new equity high in the 364 out-of-sample weeks. For this strategy, the **%P** (% of oos periods that are positive) was 63%, but the **%Wtr** (The % of all oos trades that are positive) was only 44%. This low **%Wtr** was made up for by **oW/oL** (average oos winning trades/average oos losing trades) equal to 1.79.

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 20 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 364 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 0.94 for the net equity curve.

Using this filter, the strategy generated a profit of $121,519 net equity after commissions and slippage of $30 trading one EC contract for 364 weeks. The period from March/2014 to March 2015 was a volatile market with the Euro dropping from 1.41 to 1.07. Yet the LSQV strategy did quite well making a net profit of ~$23,000 during that time. From Table 1, the largest losing week was -$5963 on the week ending 10/8/10. The largest drawdown was -$11762 from the week ending on 12/30/11 to 1/13/12. This drawdown lasted 2 weeks and took 10 weeks to recover and made a new equity. The second biggest drawdown was $6478 from 1/31/14 to 8/29/14. This drawdown recovered and made a new equity high in 7 weeks. The longest time between new equity highs was 36 weeks which was the drawdown that started on 1/31/14.

Lastly. as can be seen in **Figure 3**, the top 10 filters all did very well in the 52 ***future*** weeks from 5/05/2017 to 4/27/2018 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 seven of the 364 weeks to a high of 36 trades/week with an average of 5.2 trades/week.

Figure 1 Graph of Least Squares Velocity Strategy Net Equity Applying the Filter Each Week on Out-Of-Sample EC 1min Bar Prices 5/14/2010 to 4/28/2017 -> 4/27/2018

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 and the green dots are the new highs in net equity. The grey line is the EC Daily Closing prices superimposed on the Equity Chart.
The vertical dotted red line on the right separates the future excluded period equity from 4/28/17 to 4/27/18. This is what would have happened if you used t50mLTr|lr<3r2<80|nt>5-mDev on future data 5/5/2017-4/27/18 which was not included in the WFME filter run.

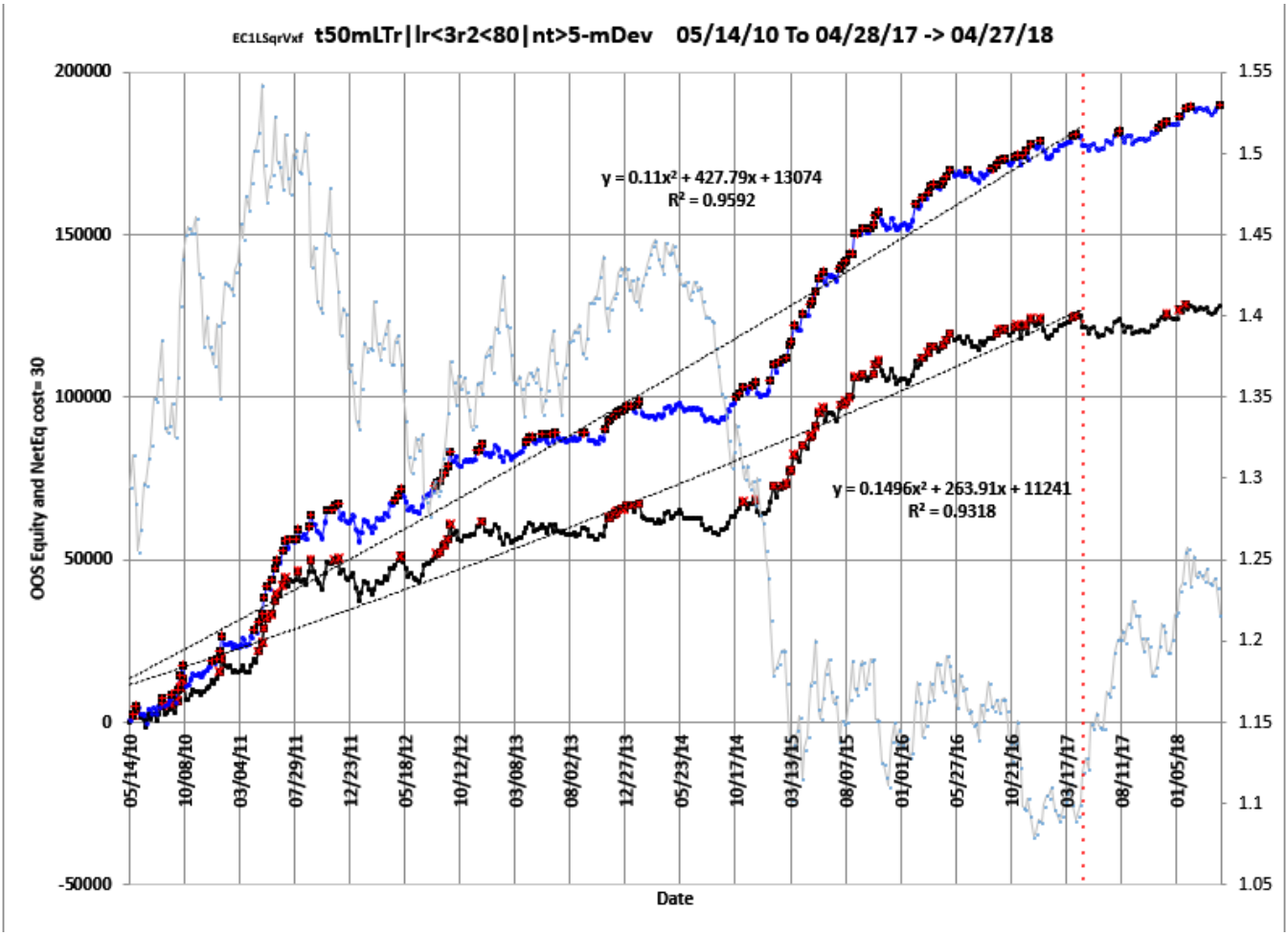

Figure 2 Walk Forward Out-Of-Sample Performance Summary for EC 1 min bars Least Squares Velocity Strategy 1 minute bar chart from 4/23/18-4/27/2018

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

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	EC1LSqrVxf	s05/14/10	e04/28/17	#364	AnyTnp	#52							
2	Filter-Metric	toGP	toNP	aoGP	aoTr	ao#T	std	skew	kur	t	oW|oL	%Wtr	%P
3	b50mDev|lr<5r2<90|nt>5-mDev	185184	129954	531	100.6	5.3	1838	0.091	4.18	5.39	1.77	44	62
4	b50mDev|lr<5r2<80|nt>5-mDev	183603	127593	523	98.3	5.3	1866	0.041	4.07	5.25	1.8	44	62
5	b50mDev|lr<5r2<90|nt>10-mDev	189349	126259	522	90.0	5.8	1875	0.019	3.96	5.3	1.8	44	64
6	t50mLTr|lr<3r2<80|nt>5-mDev	177469	121519	497	95.2	5.2	1819	0.052	3.51	5.16	1.79	44	63
7	b50mDev|lr<5r2<80|nt>10-mDev	184217	121427	507	88.0	5.8	1882	(0.003)	3.99	5.14	1.82	43	63
8	b50mDev|lr<4r2<90|nt>5-mDev	165654	119424	476	107.5	4.4	1883	(0.136)	3.69	4.72	1.68	45	61
9	t50mLTr|lr<3r2<80|nt>10-mDev	179878	119368	494	89.2	5.5	1844	0.034	3.42	5.11	1.84	43	63
10	b50mDev|lr<5|nt>5-mDev	174907	119077	501	94.0	5.3	1848	0.120	4.1	5.07	1.75	44	60
11	b50mDev|lr<5|nt>10-mDev	182341	118171	502	85.2	5.9	1865	(0.003)	3.88	5.13	1.79	43	63

	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
1	a(417.4)	s105.1	f30752					c=$30					|	s05/05/17	e04/27/18	#52				t416
2	LLtr	LLp	eqDD	wpr	lpr	#	eqA2	Dev^2	KTau	eqR2	Blw	BE	|	toGPx	toNPx	aoTRx	aoNTx	#x	tOnpNet	Prob
3	-3763	-6525	-12202	10	5	349	-1.91	14700	91	91	64	53	|	7213	3493	58	2.8	44	133447	2.83E-14
4	-3763	-6525	-15663	12	5	351	-1.62	13889	90	91	64	56	|	9089	5279	72	2.9	44	132872	5.36E-14
5	-3763	-6525	-16938	10	6	363	-2.17	16498	90	88	43	54	|	12085	6445	64	3.7	51	132704	1.65E-13
6	-2938	-5963	-11762	12	4	357	0.22	10206	95	96	36	57	|	12345	6405	62	4	50	127924	2.77E-13
7	-3763	-6525	-16938	12	6	363	-1.91	15202	91	90	42	58	|	11585	6005	62	3.6	51	127432	4.18E-13
8	-3763	-6525	-15912	9	5	348	-1.76	14050	87	89	63	69	|	7040	3350	57	2.8	44	122774	2.28E-13
9	-2938	-5963	-11028	12	4	364	0.09	9072	95	97	21	59	|	12465	5355	53	4.6	52	124723	6.58E-13
10	-3763	-6525	-11727	10	5	349	-2.07	14592	91	90	64	60	|	3906	126	31	2.9	43	119203	2.63E-13
11	-3763	-6525	-16938	10	6	363	-2.29	16353	90	88	44	58	|	11835	6135	62	3.7	51	124306	7.76E-13

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 364 oos periods (= weeks).
Col C: ***toNP -*** Total out-of-sample(oos) Net profit (toGP-Number of Trade Weeks*cost) for the 364 oos periods.
Col D: ***aoGP -*** Average oss gross profit for the 364 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 364 oos period profits and losses
Col H: ***skew -*** The Skew statistic of the 364 oos period profits and losses
Col I: ***kur -*** he kurtosis statistic of the 364 oos period profits and losses
Col J: ***t -*** The student t statistic for the 364 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: ***KTau^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: ***eqR2 -*** 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 364 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/364) 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- $2.77x10^{-13}$)^30752 ~= 30752 x $2.77x10^{-13}$ ~= 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 2 Walk Forward Out-Of-Sample Performance Summary
EC-Mini 1 min bars Least Squares Velocity Strategy

EC-1 min bars 5/14/2010 - 4/28/2017using 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: t50mLTr|lr<3r2<80nt>5-mDev

Where:
osnp = Weekly Out-of-sample gross profit in $
Equity = Running Sum of weekly out-of-sample gross profits $
NOnp$20 = Weekly Out-Of-Sample Net Profit in $ = **osnp-ont*30**.
NetEq = running sum of the weekly out-of-sample net profits in $
ollt = The largest losing trade in the out-of-sample section in $.
odd = The drawdown in the out-of-sample section in $.
ont = The number of trades in the out-of-sample week.
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$30	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
04/08/10	to	05/07/10	05/10/10	to	05/14/10	625	85	18	6963	6	-1275	-2763	625	85	40	2.4	2.8
04/15/10	to	05/14/10	05/17/10	to	05/21/10	1938	1698	8	4838	5	-1450	-2750	2563	1783	70	2.8	3.4
04/22/10	to	05/21/10	05/24/10	to	05/28/10	2238	2148	3	2238	3	0	0	4801	3931	70	3	3.6
04/29/10	to	05/28/10	05/31/10	to	06/04/10	(175)	(265)	3	1788	1	-1563	-1963	4626	3666	70	3	3.6
05/06/10	to	06/04/10	06/07/10	to	06/11/10	(2200)	(2350)	5	875	1	-1325	-2988	2426	1316	70	3.6	2.6
05/13/10	to	06/11/10	06/14/10	to	06/18/10	(38)	(218)	6	1250	3	-638	-975	2388	1098	70	3.4	3
05/20/10	to	06/18/10	06/21/10	to	06/25/10	(2513)	(2783)	9	1288	2	-1000	-3563	-125	-1685	50	1.6	3
05/27/10	to	06/25/10	06/28/10	to	07/02/10	4050	3990	2	4050	2	0	0	3925	2305	60	2.6	3.4
06/03/10	to	07/02/10	07/05/10	to	07/09/10	(1150)	(1210)	2	0	0	-588	-1150	2775	1095	50	3.2	2.2
06/10/10	to	07/09/10	07/12/10	to	07/16/10	1463	1373	3	3063	1	-963	-963	4238	2468	60	3.4	2.6
06/17/10	to	07/16/10	07/19/10	to	07/23/10	(1475)	(1835)	12	2413	5	-963	-1913	2763	633	60	3.2	1.2
06/24/10	to	07/23/10	07/26/10	to	07/30/10	2038	1888	5	2050	4	-13	-13	4801	2521	60	0.4	3.2
07/01/10	to	07/30/10	08/02/10	to	08/06/10	2700	2550	5	2725	3	-13	-13	7501	5071	50	1.2	3.4
07/08/10	to	08/06/10	08/09/10	to	08/13/10	(2213)	(2513)	10	2838	5	-2500	-4125	5288	2558	60	1.4	3.4
07/15/10	to	08/13/10	08/16/10	to	08/20/10	463	343	4	1338	2	-575	-875	5751	2901	70	1.8	3
07/22/10	to	08/20/10	08/23/10	to	08/27/10	1100	1010	3	1838	2	-738	-738	6851	3911	60	1.6	3.4
07/29/10	to	08/27/10	08/30/10	to	09/03/10	1625	1595	1	1625	1	0	0	8476	5506	50	0.2	3.2
08/05/10	to	09/03/10	09/06/10	to	09/10/10	(2400)	(2730)	11	688	4	-750	-2400	6076	2776	70	0.2	2.2
08/12/10	to	09/10/10	09/13/10	to	09/17/10	3675	3525	5	4588	2	-613	-825	9751	6301	40	0.6	3.4
08/19/10	to	09/17/10	09/20/10	to	09/24/10	4488	4278	7	5938	3	-638	-938	14239	10579	50	1.2	2.8
08/26/10	to	09/24/10	09/27/10	to	10/01/10	2938	2728	7	4238	4	-788	-788	17177	13307	40	1.2	3.6
09/02/10	to	10/01/10	10/04/10	to	10/08/10	(5963)	(6533)	19	1763	3	-1675	-6738	11214	6774	40	3.2	0.4
09/09/10	to	10/08/10	10/11/10	to	10/15/10	400	160	8	3038	4	-900	-1800	11614	6934	60	3	2
09/16/10	to	10/15/10	10/18/10	to	10/22/10	1613	1463	5	1900	4	-288	-288	13227	8397	70	3	1.6
09/23/10	to	10/22/10	10/25/10	to	10/29/10	1538	1388	5	2525	3	-575	-988	14765	9785	60	3	2
09/30/10	to	10/29/10	11/01/10	to	11/05/10	(263)	(503)	8	3000	2	-1263	-3263	14502	9282	70	3	1.4
10/07/10	to	11/05/10	11/08/10	to	11/12/10	388	118	9	2463	3	-913	-1900	14890	9400	50	3	3
10/14/10	to	11/12/10	11/15/10	to	11/19/10	(838)	(868)	1	0	0	-838	-838	14052	8532	50	2.2	3.6
10/21/10	to	11/19/10	11/22/10	to	11/26/10	1075	1015	2	3713	1	-2638	-2638	15127	9547	70	3.6	3.4
10/28/10	to	11/26/10	11/29/10	to	12/03/10	913	583	11	5938	4	-1163	-2963	16040	10130	40	2.6	3.2
11/04/10	to	12/03/10	12/06/10	to	12/10/10	1013	983	1	1013	1	0	0	17053	11113	60	3.6	3
11/11/10	to	12/10/10	12/13/10	to	12/17/10	1888	1798	3	4000	2	-2113	-2113	18941	12911	60	3.2	1.6
11/18/10	to	12/17/10	12/20/10	to	12/24/10	(788)	(908)	4	363	1	-663	-1088	18153	12003	60	3.4	3
11/25/10	to	12/24/10	12/27/10	to	12/31/10	1375	1195	6	3225	3	-1013	-1850	19528	13198	40	3.4	2.2
12/02/10	to	12/31/10	01/03/11	to	01/07/11	2438	2168	9	5675	2	-913	-2813	21966	15366	40	3.4	1.8
12/09/10	to	01/07/11	01/10/11	to	01/14/11	4200	4110	3	4613	2	-413	-413	26166	19476	50	3.4	3.6

In-Sample Dates			Out-of-Sample Dates			osnp	NOnp$30	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
12/16/10	to	01/14/11	01/17/11	to	01/21/11	(2088)	(2148)	2	850	1	-2938	-2938	24078	17328	50	3.4	3.6
12/23/10	to	01/21/11	01/24/11	to	01/28/11	(100)	(430)	11	1138	4	-288	-813	23978	16898	30	1	3.4
12/30/10	to	01/28/11	01/31/11	to	02/04/11	463	253	7	2250	3	-725	-1788	24441	17151	30	1.8	3.6
01/06/11	to	02/04/11	02/07/11	to	02/11/11	(1550)	(1760)	7	1375	2	-863	-2875	22891	15391	30	2.8	2
01/13/11	to	02/11/11	02/14/11	to	02/18/11	825	585	8	2388	4	-525	-1163	23716	15976	40	1.8	3.6
01/20/11	to	02/18/11	02/21/11	to	02/25/11	(500)	(710)	7	1450	3	-1163	-1950	23216	15266	50	3.4	0.4
01/27/11	to	02/25/11	02/28/11	to	03/04/11	500	380	4	1400	2	-538	-538	23716	15646	30	3.4	3
02/03/11	to	03/04/11	03/07/11	to	03/11/11	1975	1825	5	2113	4	-138	-138	25691	17471	40	3	0.4
02/10/11	to	03/11/11	03/14/11	to	03/18/11	(1900)	(2110)	7	1150	2	-975	-2625	23791	15361	30	3.4	2.2
02/17/11	to	03/18/11	03/21/11	to	03/25/11	275	65	7	1338	3	-388	-1063	24066	15426	50	2.6	1
02/24/11	to	03/25/11	03/28/11	to	04/01/11	2038	1918	4	3088	3	-1050	-1050	26104	17344	50	3.2	1.8
03/03/11	to	04/01/11	04/04/11	to	04/08/11	2013	1833	6	3225	3	-500	-800	28117	19177	60	2.2	2
03/10/11	to	04/08/11	04/11/11	to	04/15/11	(438)	(648)	7	1138	3	-775	-1575	27679	18529	50	3	1
03/17/11	to	04/15/11	04/18/11	to	04/22/11	3338	3188	5	4713	2	-963	-1250	31017	21717	50	1.6	2.6
03/24/11	to	04/22/11	04/25/11	to	04/29/11	2463	2373	3	2700	2	-238	-238	33480	24090	50	0.4	3.6
03/31/11	to	04/29/11	05/02/11	to	05/06/11	4813	4603	7	6525	2	-525	-1225	38293	28693	70	3	0.4
04/07/11	to	05/06/11	05/09/11	to	05/13/11	3700	3310	13	6175	5	-825	-1263	41993	32003	70	2.6	0.6
04/14/11	to	05/13/11	05/16/11	to	05/20/11	(825)	(885)	2	350	1	-1175	-1175	41168	31118	50	3.6	3.6
04/21/11	to	05/20/11	05/23/11	to	05/27/11	2450	2300	5	2750	4	-300	-300	43618	33418	50	0.8	3.6
04/28/11	to	05/27/11	05/30/11	to	06/03/11	3700	3670	1	3700	1	0	0	47318	37088	70	3	3.6
05/05/11	to	06/03/11	06/06/11	to	06/10/11	2275	2245	1	2275	1	0	0	49593	39333	70	2.8	3.4
05/12/11	to	06/10/11	06/13/11	to	06/17/11	(375)	(585)	7	2925	2	-1550	-2813	49218	38748	50	0.6	3.4
05/19/11	to	06/17/11	06/20/11	to	06/24/11	3763	3343	14	5413	8	-663	-888	52981	42091	20	2.6	3.6
05/26/11	to	06/24/11	06/27/11	to	07/01/11	2538	2178	12	4288	7	-638	-838	55519	44269	70	0.8	2
06/02/11	to	07/01/11	07/04/11	to	07/08/11	(1813)	(2503)	23	2713	9	-650	-2975	53706	41766	50	0.8	2
06/09/11	to	07/08/11	07/11/11	to	07/15/11	2538	2208	11	6063	6	-1163	-2650	56244	43974	70	3.2	0.2
06/16/11	to	07/15/11	07/18/11	to	07/22/11	(525)	(735)	7	1513	3	-1200	-1750	55719	43239	70	3.2	0.8
06/23/11	to	07/22/11	07/25/11	to	07/29/11	763	553	7	2700	4	-1263	-1263	56482	43792	70	3.2	0.6
06/30/11	to	07/29/11	08/01/11	to	08/05/11	2975	2585	13	5575	7	-1088	-1513	59457	46377	60	3.4	1
07/07/11	to	08/05/11	08/08/11	to	08/12/11	(2650)	(3190)	18	3313	6	-1075	-4913	56807	43187	60	2.6	2.6
07/14/11	to	08/12/11	08/15/11	to	08/19/11	1013	803	7	2825	3	-613	-1175	57820	43990	60	1.8	3.4
07/21/11	to	08/19/11	08/22/11	to	08/26/11	(1550)	(1820)	9	1263	3	-950	-2738	56270	42170	60	1.6	3.2
07/28/11	to	08/26/11	08/29/11	to	09/02/11	3950	3920	1	3950	1	0	0	60220	46090	70	3.2	1.4
08/04/11	to	09/02/11	09/05/11	to	09/09/11	3700	3550	5	6050	2	-1113	-1750	63920	49640	70	3.2	1.4
08/11/11	to	09/09/11	09/12/11	to	09/16/11	(3150)	(3420)	9	1088	2	-1513	-3613	60770	46220	70	3	2.6
08/18/11	to	09/16/11	09/19/11	to	09/23/11	(1800)	(2250)	15	4000	6	-1013	-3450	58970	43970	70	3	1.4
08/25/11	to	09/23/11	09/26/11	to	09/30/11	(738)	(1038)	10	4238	5	-2038	-3850	58232	42932	40	3	3.4
09/01/11	to	09/30/11	10/03/11	to	10/07/11	(1725)	(2055)	11	2900	4	-1013	-4625	56507	40877	70	2.6	2.4
09/08/11	to	10/07/11	10/10/11	to	10/14/11	5000	4910	3	5200	2	-200	-200	61507	45787	70	2.4	3.6
09/15/11	to	10/14/11	10/17/11	to	10/21/11	3525	3285	8	5650	4	-750	-1150	65032	49072	40	2.8	3.4
09/22/11	to	10/21/11	10/24/11	to	10/28/11	13	(257)	9	3888	3	-1338	-3838	65045	48815	40	3.2	3.4
09/29/11	to	10/28/11	10/31/11	to	11/04/11	375	165	7	4288	3	-2013	-3863	65420	48980	60	3.6	3.6
10/06/11	to	11/04/11	11/07/11	to	11/11/11	1263	993	9	5075	4	-1163	-3388	66683	49973	40	3.4	3.4
10/13/11	to	11/11/11	11/14/11	to	11/18/11	625	475	5	2438	2	-1550	-1550	67308	50448	60	2.6	3.6
10/20/11	to	11/18/11	11/21/11	to	11/25/11	(4600)	(4780)	6	25	1	-1713	-4600	62708	45668	50	2	3.6
10/27/11	to	11/25/11	11/28/11	to	12/02/11	1338	1158	6	2400	4	-838	-1063	64046	46826	50	1.8	3.6
11/03/11	to	12/02/11	12/05/11	to	12/09/11	(2225)	(2345)	4	163	1	-1300	-2388	61821	44481	60	3	3.6
11/10/11	to	12/09/11	12/12/11	to	12/16/11	(538)	(718)	6	1125	3	-988	-1313	61283	43763	70	1.2	3.4
11/17/11	to	12/16/11	12/19/11	to	12/23/11	1188	1098	3	1263	2	-75	-75	62471	44861	70	1.2	3.4
11/24/11	to	12/23/11	12/26/11	to	12/30/11	1025	935	3	1850	2	-825	-825	63496	45796	50	1.6	3.2
12/01/11	to	12/30/11	01/02/12	to	01/06/12	(4300)	(4510)	7	275	1	-1463	-4300	59196	41286	30	1	3.6
12/08/11	to	01/06/12	01/09/12	to	01/13/12	(3650)	(4190)	18	1750	4	-1075	-4988	55546	37096	60	1.4	2
12/15/11	to	01/13/12	01/16/12	to	01/20/12	2800	2650	5	3225	3	-400	-400	58346	39746	70	0.2	3.6
12/22/11	to	01/20/12	01/23/12	to	01/27/12	3750	3690	2	3900	1	-150	-150	62096	43436	70	0.6	3.4
12/29/11	to	01/27/12	01/30/12	to	02/03/12	(575)	(785)	7	1563	3	-750	-2063	61521	42651	30	3.2	1.8

In-Sample Dates			Out-of-Sample Dates			osnp	NOnp$30	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
01/05/12	to	02/03/12	02/06/12	to	02/10/12	(1513)	(1873)	12	2525	3	-1138	-3675	60008	40778	30	1.8	3
01/12/12	to	02/10/12	02/13/12	to	02/17/12	(1613)	(1703)	3	550	1	-1938	-2163	58395	39075	40	2	3.6
01/19/12	to	02/17/12	02/20/12	to	02/24/12	1600	1510	3	2413	1	-613	-813	59995	40585	70	1.2	2.8
01/26/12	to	02/24/12	02/27/12	to	03/02/12	2688	2598	3	3000	1	-200	-313	62683	43183	40	3.6	1
02/02/12	to	03/02/12	03/05/12	to	03/09/12	(263)	(323)	2	388	1	-650	-650	62420	42860	60	1.6	3.6
02/09/12	to	03/09/12	03/12/12	to	03/16/12	113	53	2	775	1	-663	-663	62533	42913	60	2.2	2.2
02/16/12	to	03/16/12	03/19/12	to	03/23/12	1775	1625	5	2038	3	-200	-263	64308	44538	70	0.4	2.6
02/23/12	to	03/23/12	03/26/12	to	03/30/12	(638)	(698)	2	538	1	-1175	-1175	63670	43840	60	2.2	3.4
03/01/12	to	03/30/12	04/02/12	to	04/06/12	3538	3448	3	3763	2	-225	-225	67208	47288	40	3.2	0.8
03/08/12	to	04/06/12	04/09/12	to	04/13/12	(225)	(255)	1	0	0	-225	-225	66983	47033	40	0.2	3.2
03/15/12	to	04/13/12	04/16/12	to	04/20/12	1400	1310	3	1713	2	-313	-313	68383	48343	50	1.6	3.2
03/22/12	to	04/20/12	04/23/12	to	04/27/12	1400	1310	3	1400	3	0	0	69783	49653	40	1.2	3.2
03/29/12	to	04/27/12	04/30/12	to	05/04/12	1750	1660	3	1838	2	-88	-88	71533	51313	60	2.6	0.2
04/05/12	to	05/04/12	05/07/12	to	05/11/12	(1913)	(2033)	4	13	1	-950	-1925	69620	49280	20	2.4	3.6
04/12/12	to	05/11/12	05/14/12	to	05/18/12	(1813)	(1903)	3	0	0	-1488	-1813	67807	47377	60	0.2	3.4
04/19/12	to	05/18/12	05/21/12	to	05/25/12	(2463)	(2643)	6	600	1	-1413	-2463	65344	44734	30	2.4	3.4
04/26/12	to	05/25/12	05/28/12	to	06/01/12	975	885	3	2138	2	-1163	-1163	66319	45619	60	2.2	3.4
05/03/12	to	06/01/12	06/04/12	to	06/08/12	(1363)	(1513)	5	963	1	-1088	-1388	64956	44106	30	2.4	3.6
05/10/12	to	06/08/12	06/11/12	to	06/15/12	(188)	(218)	1	0	0	-188	-188	64768	43888	70	2.6	3.6
05/17/12	to	06/15/12	06/18/12	to	06/22/12	(313)	(373)	2	850	1	-1163	-1163	64455	43515	70	3.4	3.6
05/24/12	to	06/22/12	06/25/12	to	06/29/12	2050	1960	3	2788	2	-738	-738	66505	45475	30	2.6	3.6
05/31/12	to	06/29/12	07/02/12	to	07/06/12	2850	2820	1	2850	1	0	0	69355	48295	70	2.8	2.4
06/07/12	to	07/06/12	07/09/12	to	07/13/12	438	348	3	638	2	-200	-200	69793	48643	50	3	0.2
06/14/12	to	07/13/12	07/16/12	to	07/20/12	400	280	4	1138	1	-425	-738	70193	48923	70	2	3.2
06/21/12	to	07/20/12	07/23/12	to	07/27/12	1200	1050	5	2263	2	-500	-1063	71393	49973	50	2.6	3.2
06/28/12	to	07/27/12	07/30/12	to	08/03/12	1250	920	11	3200	6	-638	-1175	72643	50893	50	0.2	2
07/05/12	to	08/03/12	08/06/12	to	08/10/12	1050	930	4	1438	2	-288	-288	73693	51823	40	3.4	0.6
07/12/12	to	08/10/12	08/13/12	to	08/17/12	538	388	5	563	2	-25	-25	74231	52211	70	0.2	2.8
07/19/12	to	08/17/12	08/20/12	to	08/24/12	2213	2183	1	2213	1	0	0	76444	54394	70	0.4	2.8
07/26/12	to	08/24/12	08/27/12	to	08/31/12	363	213	5	825	2	-225	-300	76807	54607	70	0.6	2.2
08/02/12	to	08/31/12	09/03/12	to	09/07/12	2025	1875	5	3238	2	-913	-963	78832	56482	50	1.8	2.4
08/09/12	to	09/07/12	09/10/12	to	09/14/12	4138	4108	1	4138	1	0	0	82970	60590	40	2.8	2.4
08/16/12	to	09/14/12	09/17/12	to	09/21/12	(2600)	(2810)	7	363	1	-2100	-2750	80370	57780	30	0.4	3.4
08/23/12	to	09/21/12	09/24/12	to	09/28/12	1325	1055	9	2163	5	-375	-425	81695	58835	60	1.8	1
08/30/12	to	09/28/12	10/01/12	to	10/05/12	(2713)	(2803)	3	0	0	-1513	-2713	78982	56032	30	3.6	1
09/06/12	to	10/05/12	10/08/12	to	10/12/12	(125)	(155)	1	0	0	-125	-125	78857	55877	70	3.6	2.4
09/13/12	to	10/12/12	10/15/12	to	10/19/12	1350	1320	1	1350	1	0	0	80207	57197	60	0.6	2.8
09/20/12	to	10/19/12	10/22/12	to	10/26/12	238	208	1	238	1	0	0	80445	57405	60	3.6	2.8
09/27/12	to	10/26/12	10/29/12	to	11/02/12	0	0	0	0	0	0	0	80445	57405	60	3.6	3
10/04/12	to	11/02/12	11/05/12	to	11/09/12	200	110	3	913	1	-463	-713	80645	57515	20	3.2	3.4
10/11/12	to	11/09/12	11/12/12	to	11/16/12	150	60	3	375	1	-188	-225	80795	57575	20	1.4	3.4
10/18/12	to	11/16/12	11/19/12	to	11/23/12	2825	2675	5	3438	3	-400	-613	83620	60250	20	1.4	2.8
10/25/12	to	11/23/12	11/26/12	to	11/30/12	38	8	1	38	1	0	0	83658	60258	30	1.8	3.4
11/01/12	to	11/30/12	12/03/12	to	12/07/12	1788	1698	3	1838	2	-50	-50	85446	61956	20	2	3
11/08/12	to	12/07/12	12/10/12	to	12/14/12	(2900)	(3020)	4	363	1	-2113	-3263	82546	58936	40	2.8	2.2
11/15/12	to	12/14/12	12/17/12	to	12/21/12	138	18	4	1113	2	-575	-975	82684	58954	50	2	2.6
11/22/12	to	12/21/12	12/24/12	to	12/28/12	(800)	(1010)	7	363	2	-425	-900	81884	57944	30	2.8	0.2
11/29/12	to	12/28/12	12/31/12	to	01/04/13	988	928	2	1613	1	-625	-625	82872	58872	60	2.8	2.4
12/06/12	to	01/04/13	01/07/13	to	01/11/13	2113	2083	1	2113	1	0	0	84985	60955	50	3	3
12/13/12	to	01/11/13	01/14/13	to	01/18/13	(863)	(1313)	15	900	5	-575	-1363	84122	59642	20	0.8	2.6
12/20/12	to	01/18/13	01/21/13	to	01/25/13	(2288)	(2738)	15	613	6	-725	-2288	81834	56904	20	3.2	0.6
12/27/12	to	01/25/13	01/28/13	to	02/01/13	(1613)	(1943)	11	1975	3	-2163	-3588	80221	54961	20	3.2	1
01/03/13	to	02/01/13	02/04/13	to	02/08/13	2988	2778	7	3663	5	-388	-413	83209	57739	40	3.2	1.4
01/10/13	to	02/08/13	02/11/13	to	02/15/13	(575)	(725)	5	1013	1	-675	-1588	82634	57014	60	3.4	0.6
01/17/13	to	02/15/13	02/18/13	to	02/22/13	(1563)	(1893)	11	1475	5	-1163	-2775	81071	55121	30	0.8	2.8

In-Sample Dates			Out-of-Sample Dates			osnp	NOnp$30	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
01/24/13	to	02/22/13	02/25/13	to	03/01/13	700	550	5	1850	1	-550	-1088	81771	55671	60	1.4	3.6
01/31/13	to	03/01/13	03/04/13	to	03/08/13	550	460	3	563	2	-13	-13	82321	56131	40	1.4	2.8
02/07/13	to	03/08/13	03/11/13	to	03/15/13	500	410	3	1388	1	-888	-888	82821	56541	40	1.2	3
02/14/13	to	03/15/13	03/18/13	to	03/22/13	388	268	4	1063	1	-338	-675	83209	56809	40	1.4	3.4
02/21/13	to	03/22/13	03/25/13	to	03/29/13	1638	1548	3	2638	1	-863	-1000	84847	58357	50	3.2	1.2
02/28/13	to	03/29/13	04/01/13	to	04/05/13	1388	1238	5	2600	1	-400	-1213	86235	59595	50	0.2	3
03/07/13	to	04/05/13	04/08/13	to	04/12/13	1475	1445	1	1475	1	0	0	87710	61040	40	1.2	2.8
03/14/13	to	04/12/13	04/15/13	to	04/19/13	75	(345)	14	3025	5	-625	-1550	87785	60695	70	0.8	2
03/21/13	to	04/19/13	04/22/13	to	04/26/13	(1650)	(1800)	5	338	2	-1163	-1988	86135	58895	60	2.6	2.4
03/28/13	to	04/26/13	04/29/13	to	05/03/13	725	575	5	1450	3	-538	-725	86860	59470	70	0.2	3.6
04/04/13	to	05/03/13	05/06/13	to	05/10/13	163	73	3	1150	1	-600	-988	87023	59543	60	3	2.2
04/11/13	to	05/10/13	05/13/13	to	05/17/13	1413	1383	1	1413	1	0	0	88436	60926	60	3.6	2.2
04/18/13	to	05/17/13	05/20/13	to	05/24/13	(1263)	(1383)	4	338	1	-1088	-1600	87173	59543	50	3.4	1.8
04/25/13	to	05/24/13	05/27/13	to	05/31/13	(1050)	(1170)	4	250	2	-800	-1163	86123	58373	40	3.2	3.2
05/02/13	to	05/31/13	06/03/13	to	06/07/13	2400	2310	3	2563	2	-163	-163	88523	60683	50	0.6	3.4
05/09/13	to	06/07/13	06/10/13	to	06/14/13	(1900)	(2050)	5	50	1	-650	-1950	86623	58633	30	3	3
05/16/13	to	06/14/13	06/17/13	to	06/21/13	2350	2140	7	2925	3	-388	-388	88973	60773	20	2.6	2
05/23/13	to	06/21/13	06/24/13	to	06/28/13	(1550)	(1940)	13	1038	6	-988	-2150	87423	58833	40	0.2	2.2
05/30/13	to	06/28/13	07/01/13	to	07/05/13	(538)	(598)	2	1075	1	-1613	-1613	86885	58235	60	1.2	3.6
06/06/13	to	07/05/13	07/08/13	to	07/12/13	350	290	2	1875	1	-1525	-1525	87235	58525	50	2.2	3.4
06/13/13	to	07/12/13	07/15/13	to	07/19/13	(988)	(1018)	1	0	0	-988	-988	86247	57507	60	3.2	0.4
06/20/13	to	07/19/13	07/22/13	to	07/26/13	475	445	1	475	1	0	0	86722	57952	50	2.4	3.6
06/27/13	to	07/26/13	07/29/13	to	08/02/13	388	28	12	1413	4	-300	-875	87110	57980	40	1.6	1.4
07/04/13	to	08/02/13	08/05/13	to	08/09/13	363	333	1	363	1	0	0	87473	58313	60	2	3.2
07/11/13	to	08/09/13	08/12/13	to	08/16/13	(713)	(833)	4	950	1	-875	-1663	86760	57480	60	2.6	2.6
07/18/13	to	08/16/13	08/19/13	to	08/23/13	525	495	1	525	1	0	0	87285	57975	30	0.4	3.4
07/25/13	to	08/23/13	08/26/13	to	08/30/13	1850	1820	1	1850	1	0	0	89135	59795	70	3.6	0.8
08/01/13	to	08/30/13	09/02/13	to	09/06/13	88	(2)	3	788	1	-563	-700	89223	59793	30	3.6	0.2
08/08/13	to	09/06/13	09/09/13	to	09/13/13	(525)	(555)	1	0	0	-525	-525	88698	59238	50	3.6	1.4
08/15/13	to	09/13/13	09/16/13	to	09/20/13	(1875)	(1995)	4	363	1	-1663	-2025	86823	57243	70	3.6	1.4
08/22/13	to	09/20/13	09/23/13	to	09/27/13	38	8	1	38	1	0	0	86861	57251	40	3.2	0.6
08/29/13	to	09/27/13	09/30/13	to	10/04/13	(725)	(815)	3	50	1	-625	-725	86136	56436	40	3	2.6
09/05/13	to	10/04/13	10/07/13	to	10/11/13	0	0	0	0	0	0	0	86136	56436	40	3	3
09/12/13	to	10/11/13	10/14/13	to	10/18/13	1350	1200	5	2263	2	-875	-913	87486	57636	30	2.6	2
09/19/13	to	10/18/13	10/21/13	to	10/25/13	(550)	(610)	2	138	1	-688	-688	86936	57026	50	2.4	1.4
09/26/13	to	10/25/13	10/28/13	to	11/01/13	3400	3310	3	3763	1	-213	-363	90336	60336	50	2.4	1.4
10/03/13	to	11/01/13	11/04/13	to	11/08/13	2425	2275	5	3750	3	-1000	-1325	92761	62611	50	2.4	1.2
10/10/13	to	11/08/13	11/11/13	to	11/15/13	175	115	2	650	1	-475	-475	92936	62726	60	2.6	3.2
10/17/13	to	11/15/13	11/18/13	to	11/22/13	963	903	2	1088	1	-125	-125	93899	63629	70	2	3.6
10/24/13	to	11/22/13	11/25/13	to	11/29/13	525	495	1	525	1	0	0	94424	64124	50	1.2	2.6
10/31/13	to	11/29/13	12/02/13	to	12/06/13	1363	1333	1	1363	1	0	0	95787	65457	60	2.6	3.6
11/07/13	to	12/06/13	12/09/13	to	12/13/13	75	45	1	75	1	0	0	95862	65502	50	2.4	1.2
11/14/13	to	12/13/13	12/16/13	to	12/20/13	388	298	3	638	1	-200	-200	96250	65800	60	0.2	2
11/21/13	to	12/20/13	12/23/13	to	12/27/13	750	720	1	750	1	0	0	97000	66520	60	0.4	2.2
11/28/13	to	12/27/13	12/30/13	to	01/03/14	(325)	(445)	4	875	2	-625	-650	96675	66075	60	0.8	2
12/05/13	to	01/03/14	01/06/14	to	01/10/14	563	473	3	1163	1	-425	-600	97238	66548	70	0.4	2.2
12/12/13	to	01/10/14	01/13/14	to	01/17/14	(1638)	(1788)	5	100	1	-763	-1638	95600	64760	70	0.4	2.2
12/19/13	to	01/17/14	01/20/14	to	01/24/14	1900	1750	5	2100	3	-163	-163	97500	66510	70	0.2	1.6
12/26/13	to	01/24/14	01/27/14	to	01/31/14	1163	833	11	2300	6	-325	-850	98663	67343	50	1	1.2
01/02/14	to	01/31/14	02/03/14	to	02/07/14	(3625)	(4015)	13	500	1	-575	-3625	95038	63328	50	2.2	0.8
01/09/14	to	02/07/14	02/10/14	to	02/14/14	(750)	(840)	3	88	1	-488	-750	94288	62488	30	3.6	1
01/16/14	to	02/14/14	02/17/14	to	02/21/14	(300)	(480)	6	213	2	-213	-350	93988	62008	20	1.2	2.4
01/23/14	to	02/21/14	02/24/14	to	02/28/14	225	75	5	1838	2	-750	-1613	94213	62083	30	1.2	2.4
01/30/14	to	02/28/14	03/03/14	to	03/07/14	88	(2)	3	675	1	-475	-475	94301	62081	50	3.6	1.4
02/06/14	to	03/07/14	03/10/14	to	03/14/14	(725)	(935)	7	450	3	-600	-1138	93576	61146	60	1.6	0.6

In-Sample Dates			Out-of-Sample Dates			osnp	NOnp$30	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
02/13/14	to	03/14/14	03/17/14	to	03/21/14	1163	1133	1	1163	1	0	0	94739	62279	70	3.2	1
02/20/14	to	03/21/14	03/24/14	to	03/28/14	(763)	(853)	3	750	1	-900	-1513	93976	61426	70	3.4	1
02/27/14	to	03/28/14	03/31/14	to	04/04/14	425	395	1	425	1	0	0	94401	61821	50	2.8	1.4
03/06/14	to	04/04/14	04/07/14	to	04/11/14	2288	2258	1	2288	1	0	0	96689	64079	60	0.2	2.6
03/13/14	to	04/11/14	04/14/14	to	04/18/14	475	445	1	475	1	0	0	97164	64524	60	2.4	1.4
03/20/14	to	04/18/14	04/21/14	to	04/25/14	(1713)	(1803)	3	0	0	-663	-1713	95451	62721	60	2	1.4
03/27/14	to	04/25/14	04/28/14	to	05/02/14	725	545	6	1163	4	-375	-375	96176	63266	70	1.8	0.4
04/03/14	to	05/02/14	05/05/14	to	05/09/14	1225	1165	2	1588	1	-363	-363	97401	64431	70	1.8	3.6
04/10/14	to	05/09/14	05/12/14	to	05/16/14	725	695	1	725	1	0	0	98126	65126	20	3.6	1.6
04/17/14	to	05/16/14	05/19/14	to	05/23/14	(1075)	(1105)	1	0	0	-1075	-1075	97051	64021	40	0.8	2.6
04/24/14	to	05/23/14	05/26/14	to	05/30/14	(975)	(1185)	7	88	2	-325	-1063	96076	62836	70	1.4	0.2
05/01/14	to	05/30/14	06/02/14	to	06/06/14	250	(80)	11	1825	3	-375	-1325	96326	62756	60	1.4	0.2
05/08/14	to	06/06/14	06/09/14	to	06/13/14	213	183	1	213	1	0	0	96539	62939	70	2.8	2.2
05/15/14	to	06/13/14	06/16/14	to	06/20/14	0	0	0	0	0	0	0	96539	62939	70	2.8	2.2
05/22/14	to	06/20/14	06/23/14	to	06/27/14	0	0	0	0	0	0	0	96539	62939	40	3.4	1.8
05/29/14	to	06/27/14	06/30/14	to	07/04/14	25	(5)	1	25	1	0	0	96564	62934	70	3.6	1.8
06/05/14	to	07/04/14	07/07/14	to	07/11/14	(225)	(255)	1	0	0	-225	-225	96339	62679	40	3.6	1.4
06/12/14	to	07/11/14	07/14/14	to	07/18/14	(1800)	(1920)	4	138	1	-1163	-1938	94539	60759	20	1	2.4
06/19/14	to	07/18/14	07/21/14	to	07/25/14	(1438)	(1618)	6	200	1	-1025	-1438	93101	59141	20	0.2	1.8
06/26/14	to	07/25/14	07/28/14	to	08/01/14	50	(40)	3	663	2	-613	-613	93151	59101	50	0.2	1.2
07/03/14	to	08/01/14	08/04/14	to	08/08/14	525	495	1	525	1	0	0	93676	59596	60	1	2.6
07/10/14	to	08/08/14	08/11/14	to	08/15/14	(975)	(1125)	5	38	1	-625	-975	92701	58471	30	2.4	1.2
07/17/14	to	08/15/14	08/18/14	to	08/22/14	0	0	0	0	0	0	0	92701	58471	60	1.4	2.4
07/24/14	to	08/22/14	08/25/14	to	08/29/14	(525)	(615)	3	138	2	-663	-663	92176	57856	40	2.2	2.2
07/31/14	to	08/29/14	09/01/14	to	09/05/14	1225	1195	1	1225	1	0	0	93401	59051	70	1.8	2.4
08/07/14	to	09/05/14	09/08/14	to	09/12/14	150	120	1	150	1	0	0	93551	59171	60	2.2	3.6
08/14/14	to	09/12/14	09/15/14	to	09/19/14	425	365	2	1125	1	-700	-700	93976	59536	60	2.2	2.6
08/21/14	to	09/19/14	09/22/14	to	09/26/14	1913	1823	3	1913	3	0	0	95889	61359	30	1.8	1.4
08/28/14	to	09/26/14	09/29/14	to	10/03/14	1888	1798	3	1988	2	-100	-100	97777	63157	20	3.4	0.2
09/04/14	to	10/03/14	10/06/14	to	10/10/14	475	(155)	21	2575	11	-313	-1025	98252	63002	20	1.8	1.8
09/11/14	to	10/10/14	10/13/14	to	10/17/14	2063	1733	11	3213	7	-750	-788	100315	64735	40	0.6	2
09/18/14	to	10/17/14	10/20/14	to	10/24/14	888	858	1	888	1	0	0	101203	65593	60	3.6	1
09/25/14	to	10/24/14	10/27/14	to	10/31/14	2138	2048	3	2763	1	-613	-625	103341	67641	60	3.2	0.6
10/02/14	to	10/31/14	11/03/14	to	11/07/14	(350)	(380)	1	0	0	-350	-350	102991	67261	60	3.6	3.6
10/09/14	to	11/07/14	11/10/14	to	11/14/14	(1400)	(1550)	5	0	0	-950	-1400	101591	65711	50	3.2	0.6
10/16/14	to	11/14/14	11/17/14	to	11/21/14	1363	1333	1	1363	1	0	0	102954	67044	40	3.4	2
10/23/14	to	11/21/14	11/24/14	to	11/28/14	425	305	4	963	1	-325	-350	103379	67349	40	0.8	2.4
10/30/14	to	11/28/14	12/01/14	to	12/05/14	1125	975	5	2100	2	-588	-975	104504	68324	70	3.4	0.2
11/06/14	to	12/05/14	12/08/14	to	12/12/14	(3288)	(3438)	5	0	0	-2063	-3288	101216	64886	20	3.6	2
11/13/14	to	12/12/14	12/15/14	to	12/19/14	(1013)	(1253)	8	2163	4	-1188	-2050	100203	63633	40	3	2.4
11/20/14	to	12/19/14	12/22/14	to	12/26/14	475	385	3	513	2	-38	-38	100678	64018	20	3.4	0.4
11/27/14	to	12/26/14	12/29/14	to	01/02/15	0	0	0	0	0	0	0	100678	64018	70	2.8	3
12/04/14	to	01/02/15	01/05/15	to	01/09/15	1213	1183	1	1213	1	0	0	101891	65201	40	3.4	2.4
12/11/14	to	01/09/15	01/12/15	to	01/16/15	3013	2353	22	5400	11	-463	-1100	104904	67554	50	1.6	0.4
12/18/14	to	01/16/15	01/19/15	to	01/23/15	4950	4890	2	4950	2	0	0	109854	72444	70	3.2	2.4
12/25/14	to	01/23/15	01/26/15	to	01/30/15	(2138)	(3128)	33	3500	13	-675	-2175	107716	69316	50	1.6	1.2
01/01/15	to	01/30/15	02/02/15	to	02/06/15	2838	2658	6	4313	4	-925	-1475	110554	71974	40	2.6	2.4
01/08/15	to	02/06/15	02/09/15	to	02/13/15	(288)	(378)	3	1100	1	-963	-1388	110266	71596	70	1.2	2.6
01/15/15	to	02/13/15	02/16/15	to	02/20/15	1150	1030	4	1225	3	-75	-75	111416	72626	70	1.2	2.6
01/22/15	to	02/20/15	02/23/15	to	02/27/15	825	795	1	825	1	0	0	112241	73421	60	3.2	3.4
01/29/15	to	02/27/15	03/02/15	to	03/06/15	3625	3595	1	3625	1	0	0	115866	77016	30	3.4	3.2
02/05/15	to	03/06/15	03/09/15	to	03/13/15	1138	688	15	4475	6	-1113	-1925	117004	77704	20	3.2	2.8
02/12/15	to	03/13/15	03/16/15	to	03/20/15	5038	4648	13	8363	7	-1088	-2313	122042	82352	30	2	3.6
02/19/15	to	03/20/15	03/23/15	to	03/27/15	(1200)	(1410)	7	963	3	-925	-1675	120842	80942	60	2.6	2.6
02/26/15	to	03/27/15	03/30/15	to	04/03/15	(213)	(543)	11	1513	5	-650	-1725	120629	80399	60	2.6	0.8

In-Sample Dates			Out-of-Sample Dates			osnp	NOnp$30	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
03/05/15	to	04/03/15	04/06/15	to	04/10/15	4925	4895	1	4925	1	0	0	125554	85294	70	2.6	0.6
03/12/15	to	04/10/15	04/13/15	to	04/17/15	(188)	(578)	13	2013	7	-1063	-1188	125366	84716	60	2.6	1.4
03/19/15	to	04/17/15	04/20/15	to	04/24/15	(300)	(450)	5	1288	2	-613	-1588	125066	84266	50	1.8	2.8
03/26/15	to	04/24/15	04/27/15	to	05/01/15	3313	3163	5	3675	3	-250	-250	128379	87429	60	0.2	3.6
04/02/15	to	05/01/15	05/04/15	to	05/08/15	1163	953	7	2938	4	-763	-1500	129542	88382	60	3	1.6
04/09/15	to	05/08/15	05/11/15	to	05/15/15	2838	2808	1	2838	1	0	0	132380	91190	50	2.6	3.6
04/16/15	to	05/15/15	05/18/15	to	05/22/15	4188	4098	3	4525	2	-338	-338	136568	95288	60	3	1.6
04/23/15	to	05/22/15	05/25/15	to	05/29/15	(138)	(168)	1	0	0	-138	-138	136430	95120	60	0.2	3.6
04/30/15	to	05/29/15	06/01/15	to	06/05/15	1938	1608	11	5200	5	-1538	-2500	138368	96728	40	0.2	3.6
05/07/15	to	06/05/15	06/08/15	to	06/12/15	(3600)	(3990)	13	913	3	-1663	-3675	134768	92738	30	3.6	1
05/14/15	to	06/12/15	06/15/15	to	06/19/15	2650	2470	6	2713	5	-63	-63	137418	95208	30	1.8	3.4
05/21/15	to	06/19/15	06/22/15	to	06/26/15	(88)	(298)	7	2075	2	-550	-1088	137330	94910	40	2.4	2.4
05/28/15	to	06/26/15	06/29/15	to	07/03/15	(138)	(438)	10	2500	4	-800	-1538	137192	94472	40	2.4	2.4
06/04/15	to	07/03/15	07/06/15	to	07/10/15	(1275)	(1605)	11	1263	4	-525	-2275	135917	92867	20	3	2.4
06/11/15	to	07/10/15	07/13/15	to	07/17/15	3625	3595	1	3625	1	0	0	139542	96462	60	3.6	3.6
06/18/15	to	07/17/15	07/20/15	to	07/24/15	1175	1085	3	1375	2	-200	-200	140717	97547	40	1.4	3.4
06/25/15	to	07/24/15	07/27/15	to	07/31/15	600	360	8	2075	4	-538	-800	141317	97907	20	3.6	1.8
07/02/15	to	07/31/15	08/03/15	to	08/07/15	788	578	7	2038	4	-838	-838	142105	98485	60	0.6	3.2
07/09/15	to	08/07/15	08/10/15	to	08/14/15	1800	1770	1	1800	1	0	0	143905	100255	50	0.2	3.6
07/16/15	to	08/14/15	08/17/15	to	08/21/15	88	(2)	3	2025	1	-1613	-1613	143993	100253	20	3.4	2.6
07/23/15	to	08/21/15	08/24/15	to	08/28/15	6263	5723	18	8525	10	-663	-1313	150256	105976	20	3.4	2.8
07/30/15	to	08/28/15	08/31/15	to	09/04/15	175	(275)	15	2938	7	-613	-2075	150431	105701	60	1.6	0.6
08/06/15	to	09/04/15	09/07/15	to	09/11/15	(200)	(290)	3	875	1	-938	-1075	150231	105411	40	3	2.2
08/13/15	to	09/11/15	09/14/15	to	09/18/15	1675	1525	5	3150	4	-1475	-1475	151906	106936	40	2.4	1.4
08/20/15	to	09/18/15	09/21/15	to	09/25/15	(213)	(723)	17	2963	5	-600	-1875	151693	106213	50	1.8	1
08/27/15	to	09/25/15	09/28/15	to	10/02/15	(1113)	(1143)	1	0	0	-1113	-1113	150580	105070	70	3.4	3
09/03/15	to	10/02/15	10/05/15	to	10/09/15	1375	1225	5	1575	4	-200	-200	151955	106295	70	0.2	2.4
09/10/15	to	10/09/15	10/12/15	to	10/16/15	1088	1028	2	1150	1	-63	-63	153043	107323	70	2.2	2.6
09/17/15	to	10/16/15	10/19/15	to	10/23/15	2938	2908	1	2938	1	0	0	155981	110231	70	2.2	2.6
09/24/15	to	10/23/15	10/26/15	to	10/30/15	1213	1093	4	1863	3	-650	-650	157194	111324	60	2	2.2
10/01/15	to	10/30/15	11/02/15	to	11/06/15	(2750)	(3260)	17	1225	4	-2125	-3138	154444	108064	60	0.8	1.2
10/08/15	to	11/06/15	11/09/15	to	11/13/15	(1438)	(1588)	5	200	1	-863	-1638	153006	106476	30	3	0.2
10/15/15	to	11/13/15	11/16/15	to	11/20/15	(1100)	(1160)	2	0	0	-925	-1100	151906	105316	70	2.8	3.4
10/22/15	to	11/20/15	11/23/15	to	11/27/15	125	95	1	125	1	0	0	152031	105411	60	3	3.4
10/29/15	to	11/27/15	11/30/15	to	12/04/15	3025	2965	2	3025	2	0	0	155056	108376	60	3.4	3.4
11/05/15	to	12/04/15	12/07/15	to	12/11/15	(2325)	(2415)	3	0	0	-1613	-2325	152731	105961	60	3	0.8
11/12/15	to	12/11/15	12/14/15	to	12/18/15	(1200)	(1620)	14	1650	7	-713	-2250	151531	104341	30	0.6	2.4
11/19/15	to	12/18/15	12/21/15	to	12/25/15	713	683	1	713	1	0	0	152244	105024	70	1.6	2.4
11/26/15	to	12/25/15	12/28/15	to	01/01/16	775	745	1	775	1	0	0	153019	105769	50	2.6	3.6
12/03/15	to	01/01/16	01/04/16	to	01/08/16	200	(10)	7	1925	3	-788	-1625	153219	105759	60	1.4	2.2
12/10/15	to	01/08/16	01/11/16	to	01/15/16	(1388)	(1538)	5	594	2	-1169	-1981	151831	104221	70	3.2	1.8
12/17/15	to	01/15/16	01/18/16	to	01/22/16	1056	906	5	2025	2	-731	-969	152887	105127	60	2.8	0.4
12/24/15	to	01/22/16	01/25/16	to	01/29/16	1406	1316	3	1406	3	0	0	154293	106443	40	0.2	3.4
12/31/15	to	01/29/16	02/01/16	to	02/05/16	5156	4706	15	5813	9	-263	-281	159449	111149	20	0.2	3
01/07/16	to	02/05/16	02/08/16	to	02/12/16	(1238)	(2048)	27	4269	7	-681	-3994	158211	109101	20	1.6	2.6
01/14/16	to	02/12/16	02/15/16	to	02/19/16	925	835	3	1713	1	-575	-788	159136	109936	20	2.8	0.6
01/21/16	to	02/19/16	02/22/16	to	02/26/16	2263	2113	5	2456	4	-194	-194	161399	112049	20	2.8	0.8
01/28/16	to	02/26/16	02/29/16	to	03/04/16	(450)	(540)	3	294	1	-594	-594	160949	111509	60	3	2.4
02/04/16	to	03/04/16	03/07/16	to	03/11/16	2050	1990	2	2725	1	-675	-675	162999	113499	40	3.6	2.8
02/11/16	to	03/11/16	03/14/16	to	03/18/16	1875	1845	1	1875	1	0	0	164874	115344	50	2.4	2.6
02/18/16	to	03/18/16	03/21/16	to	03/25/16	450	420	1	450	1	0	0	165324	115764	50	2.4	2.6
02/25/16	to	03/25/16	03/28/16	to	04/01/16	(594)	(684)	3	1156	1	-1150	-1150	164730	115080	50	3.6	2.6
03/03/16	to	04/01/16	04/04/16	to	04/08/16	(500)	(770)	9	775	2	-488	-925	164230	114310	30	2.4	0.8
03/10/16	to	04/08/16	04/11/16	to	04/15/16	1188	798	13	2413	4	-375	-581	165418	115108	30	2	0.4
03/17/16	to	04/15/16	04/18/16	to	04/22/16	1088	1058	1	1088	1	0	0	166506	116166	70	3.6	2.4

In-Sample Dates			Out-of-Sample Dates			osnp	NOnp$30	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
03/24/16	to	04/22/16	04/25/16	to	04/29/16	1631	1601	1	1631	1	0	0	168137	117767	30	2.2	3
03/31/16	to	04/29/16	05/02/16	to	05/06/16	1681	1621	2	1681	2	0	0	169818	119388	70	2	2
04/07/16	to	05/06/16	05/09/16	to	05/13/16	(144)	(204)	2	575	1	-719	-719	169674	119184	60	1.4	1.6
04/14/16	to	05/13/16	05/16/16	to	05/20/16	(1375)	(1435)	2	63	1	-1438	-1438	168299	117749	70	1.6	2.2
04/21/16	to	05/20/16	05/23/16	to	05/27/16	319	229	3	800	2	-481	-481	168618	117978	50	1.6	1.6
04/28/16	to	05/27/16	05/30/16	to	06/03/16	681	621	2	1738	1	-1056	-1056	169299	118599	30	2.4	2
05/05/16	to	06/03/16	06/06/16	to	06/10/16	(1169)	(1499)	11	794	2	-625	-1544	168130	117100	60	0.2	1.4
05/12/16	to	06/10/16	06/13/16	to	06/17/16	(106)	(316)	7	1394	2	-475	-850	168024	116784	30	3.2	0.4
05/19/16	to	06/17/16	06/20/16	to	06/24/16	1944	1674	9	4525	5	-1244	-1244	169968	118458	70	1	3.6
05/26/16	to	06/24/16	06/27/16	to	07/01/16	(1144)	(1174)	1	0	0	-1144	-1144	168824	117284	60	3.4	2.8
06/02/16	to	07/01/16	07/04/16	to	07/08/16	(1506)	(1536)	1	0	0	-1506	-1506	167318	115748	70	2	3.6
06/09/16	to	07/08/16	07/11/16	to	07/15/16	(219)	(249)	1	0	0	-219	-219	167099	115499	70	1	3.6
06/16/16	to	07/15/16	07/18/16	to	07/22/16	(881)	(941)	2	0	0	-838	-881	166218	114558	70	1.8	2.8
06/23/16	to	07/22/16	07/25/16	to	07/29/16	2631	2601	1	2631	1	0	0	168849	117159	70	0.2	3.4
06/30/16	to	07/29/16	08/01/16	to	08/05/16	(1056)	(1146)	3	56	1	-988	-1056	167793	116013	20	1.2	2.8
07/07/16	to	08/05/16	08/08/16	to	08/12/16	863	833	1	863	1	0	0	168656	116846	20	1.2	3
07/14/16	to	08/12/16	08/15/16	to	08/19/16	1225	1075	5	1794	2	-325	-569	169881	117921	20	1.2	3
07/21/16	to	08/19/16	08/22/16	to	08/26/16	306	246	2	1013	1	-706	-706	170187	118167	50	1.6	2.4
07/28/16	to	08/26/16	08/29/16	to	09/02/16	81	21	2	156	1	-75	-75	170268	118188	40	2	3.2
08/04/16	to	09/02/16	09/05/16	to	09/09/16	1356	1296	2	1356	2	0	0	171624	119484	40	2	3
08/11/16	to	09/09/16	09/12/16	to	09/16/16	1044	1014	1	1044	1	0	0	172668	120498	60	3.6	0.4
08/18/16	to	09/16/16	09/19/16	to	09/23/16	175	145	1	175	1	0	0	172843	120643	70	1.8	3.2
08/25/16	to	09/23/16	09/26/16	to	09/30/16	431	401	1	431	1	0	0	173274	121044	70	1.8	3.2
09/01/16	to	09/30/16	10/03/16	to	10/07/16	(756)	(846)	3	0	0	-606	-756	172518	120198	40	0.6	2
09/08/16	to	10/07/16	10/10/16	to	10/14/16	(906)	(936)	1	0	0	-906	-906	171612	119262	70	1.6	3.2
09/15/16	to	10/14/16	10/17/16	to	10/21/16	981	951	1	981	1	0	0	172593	120213	40	3.2	2.6
09/22/16	to	10/21/16	10/24/16	to	10/28/16	1150	1120	1	1150	1	0	0	173743	121333	50	2.4	2.6
09/29/16	to	10/28/16	10/31/16	to	11/04/16	550	520	1	550	1	0	0	174293	121853	50	2	2
10/06/16	to	11/04/16	11/07/16	to	11/11/16	(2806)	(3886)	36	4981	12	-800	-3594	171487	117967	30	1.4	1.2
10/13/16	to	11/11/16	11/14/16	to	11/18/16	2988	2958	1	2988	1	0	0	174475	120925	60	3	2.2
10/20/16	to	11/18/16	11/21/16	to	11/25/16	1256	1196	2	1256	2	0	0	175731	122121	20	3.2	1.8
10/27/16	to	11/25/16	11/28/16	to	12/02/16	(2419)	(2569)	5	425	1	-863	-2844	173312	119552	60	2	1.8
11/03/16	to	12/02/16	12/05/16	to	12/09/16	4394	4304	3	4550	2	-156	-156	177706	123856	40	2.2	2.6
11/10/16	to	12/09/16	12/12/16	to	12/16/16	(150)	(600)	15	2656	7	-663	-994	177556	123256	70	1.6	0.8
11/17/16	to	12/16/16	12/19/16	to	12/23/16	(813)	(963)	5	438	3	-775	-1250	176743	122293	40	2.4	1
11/24/16	to	12/23/16	12/26/16	to	12/30/16	525	375	5	1200	4	-675	-675	177268	122668	40	2.4	1
12/01/16	to	12/30/16	01/02/17	to	01/06/17	1656	1296	12	3163	5	-500	-781	178924	123964	70	0.4	1.6
12/08/16	to	01/06/17	01/09/17	to	01/13/17	(3113)	(3293)	6	788	1	-1838	-3113	175811	120671	50	2.2	2
12/15/16	to	01/13/17	01/16/17	to	01/20/17	(2025)	(2085)	2	0	0	-1075	-2025	173786	118586	50	2.2	3.4
12/22/16	to	01/20/17	01/23/17	to	01/27/17	(331)	(361)	1	0	0	-331	-331	173455	118225	30	2.6	3
12/29/16	to	01/27/17	01/30/17	to	02/03/17	756	666	3	1750	1	-931	-994	174211	118891	70	0.4	2.6
01/05/17	to	02/03/17	02/06/17	to	02/10/17	1763	1733	1	1763	1	0	0	175974	120624	40	2.4	0.2
01/12/17	to	02/10/17	02/13/17	to	02/17/17	156	126	1	156	1	0	0	176130	120750	30	2.4	0.2
01/19/17	to	02/17/17	02/20/17	to	02/24/17	1375	1285	3	1375	3	0	0	177505	122035	30	2.2	1.6
01/26/17	to	02/24/17	02/27/17	to	03/03/17	0	(30)	1	0	0	0	0	177505	122005	60	1.6	2.6
02/02/17	to	03/03/17	03/06/17	to	03/10/17	469	439	1	469	1	0	0	177974	122444	40	2	3.6
02/09/17	to	03/10/17	03/13/17	to	03/17/17	463	403	2	519	1	-56	-56	178437	122847	40	3	2.8
02/16/17	to	03/17/17	03/20/17	to	03/24/17	0	0	0	0	0	0	0	178437	122847	50	2.4	2.4
02/23/17	to	03/24/17	03/27/17	to	03/31/17	1863	1833	1	1863	1	0	0	180300	124680	40	3.4	1.8
03/02/17	to	03/31/17	04/03/17	to	04/07/17	500	470	1	500	1	0	0	180800	125150	60	2.4	1.8
03/09/17	to	04/07/17	04/10/17	to	04/14/17	(494)	(524)	1	0	0	-494	-494	180306	124626	50	2.4	2.4
03/16/17	to	04/14/17	04/17/17	to	04/21/17	219	189	1	219	1	0	0	180525	124815	30	2.2	1.8
03/23/17	to	04/21/17	04/24/17	to	04/28/17	(3056)	(3296)	8	69	1	-706	-3125	177469	121519	30	2.2	1.8
03/30/17	to	04/28/17	05/01/17	to	05/05/17	0	0	0	0	0	0	0	177469	121519	70	3.6	2.2
04/06/17	to	05/05/17	05/08/17	to	05/12/17	(1663)	(1813)	5	0	0	-581	-1663	175806	119706	20	1	2

In-Sample Dates			Out-of-Sample Dates			osnp	NOnp$30	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
04/13/17	to	05/12/17	05/15/17	to	05/19/17	1475	1385	3	1975	2	-500	-500	177281	121091	30	1.2	2.4
04/20/17	to	05/19/17	05/22/17	to	05/26/17	463	253	7	1081	4	-250	-250	177744	121344	20	2.8	1.2
04/27/17	to	05/26/17	05/29/17	to	06/02/17	(1150)	(1780)	21	1194	7	-363	-1856	176594	119564	20	1.6	0.2
05/04/17	to	06/02/17	06/05/17	to	06/09/17	(781)	(871)	3	131	1	-594	-781	175813	118693	30	0.6	2.4
05/11/17	to	06/09/17	06/12/17	to	06/16/17	713	503	7	1444	3	-481	-719	176526	119196	20	2.2	1.2
05/18/17	to	06/16/17	06/19/17	to	06/23/17	(163)	(193)	1	0	0	-163	-163	176363	119003	40	0.2	3.4
05/25/17	to	06/23/17	06/26/17	to	06/30/17	2375	2225	5	2588	3	-188	-188	178738	121228	20	0.2	2.4
06/01/17	to	06/30/17	07/03/17	to	07/07/17	(475)	(625)	5	700	3	-1056	-1175	178263	120603	30	0.2	2.2
06/08/17	to	07/07/17	07/10/17	to	07/14/17	(250)	(310)	2	138	1	-388	-388	178013	120293	60	3.4	1.4
06/15/17	to	07/14/17	07/17/17	to	07/21/17	2538	2508	1	2538	1	0	0	180551	122801	40	0.6	2.4
06/22/17	to	07/21/17	07/24/17	to	07/28/17	856	826	1	856	1	0	0	181407	123627	40	1.6	2.8
06/29/17	to	07/28/17	07/31/17	to	08/04/17	363	303	2	363	2	0	0	181770	123930	40	1.4	3
07/06/17	to	08/04/17	08/07/17	to	08/11/17	(1688)	(1958)	9	800	3	-713	-1863	180082	121972	20	2.2	2.2
07/13/17	to	08/11/17	08/14/17	to	08/18/17	(1594)	(2044)	15	1094	6	-1563	-2200	178488	119928	30	0.4	2.2
07/20/17	to	08/18/17	08/21/17	to	08/25/17	1750	1720	1	1750	1	0	0	180238	121648	60	1.6	2.8
07/27/17	to	08/25/17	08/28/17	to	09/01/17	(38)	(68)	1	0	0	-38	-38	180200	121580	50	3.2	2.6
08/03/17	to	09/01/17	09/04/17	to	09/08/17	(2181)	(2271)	3	0	0	-1044	-2181	178019	119309	50	2.8	2.6
08/10/17	to	09/08/17	09/11/17	to	09/15/17	775	715	2	775	2	0	0	178794	120024	60	1.6	2.4
08/17/17	to	09/15/17	09/18/17	to	09/22/17	419	209	7	1025	2	-294	-606	179213	120233	50	0.2	2
08/24/17	to	09/22/17	09/25/17	to	09/29/17	138	108	1	138	1	0	0	179351	120341	60	2	3.2
08/31/17	to	09/29/17	10/02/17	to	10/06/17	81	51	1	81	1	0	0	179432	120392	60	2	3.2
09/07/17	to	10/06/17	10/09/17	to	10/13/17	(488)	(518)	1	0	0	-488	-488	178944	119874	50	2.2	3.2
09/14/17	to	10/13/17	10/16/17	to	10/20/17	413	383	1	413	1	0	0	179357	120257	70	1.8	2.2
09/21/17	to	10/20/17	10/23/17	to	10/27/17	1969	1939	1	1969	1	0	0	181326	122196	70	1.8	2.2
09/28/17	to	10/27/17	10/30/17	to	11/03/17	(650)	(680)	1	0	0	-650	-650	180676	121516	50	1.4	3
10/05/17	to	11/03/17	11/06/17	to	11/10/17	531	501	1	531	1	0	0	181207	122017	70	0.6	2.2
10/12/17	to	11/10/17	11/13/17	to	11/17/17	1456	1426	1	1456	1	0	0	182663	123443	30	1.2	3.6
10/19/17	to	11/17/17	11/20/17	to	11/24/17	1138	1078	2	1675	1	-538	-538	183801	124521	70	2	1.8
10/26/17	to	11/24/17	11/27/17	to	12/01/17	(419)	(449)	1	0	0	-419	-419	183382	124072	30	1	2.8
11/02/17	to	12/01/17	12/04/17	to	12/08/17	1625	1565	2	1625	2	0	0	185007	125637	20	2.4	2.8
11/09/17	to	12/08/17	12/11/17	to	12/15/17	(988)	(1138)	5	406	1	-550	-1394	184019	124499	20	1.2	2.4
11/16/17	to	12/15/17	12/18/17	to	12/22/17	(225)	(255)	1	0	0	-225	-225	183794	124244	50	2.2	3
11/23/17	to	12/22/17	12/25/17	to	12/29/17	0	0	0	0	0	0	0	183794	124244	50	2	3.4
11/30/17	to	12/29/17	01/01/18	to	01/05/18	38	8	1	38	1	0	0	183832	124252	60	1.8	2.4
12/07/17	to	01/05/18	01/08/18	to	01/12/18	2581	2551	1	2581	1	0	0	186413	126803	70	1.4	1.8
12/14/17	to	01/12/18	01/15/18	to	01/19/18	(88)	(958)	29	2656	11	-406	-1700	186325	125845	30	0.2	1.8
12/21/17	to	01/19/18	01/22/18	to	01/26/18	2669	2519	5	2669	5	0	0	188994	128364	70	0.2	2.4
12/28/17	to	01/26/18	01/29/18	to	02/02/18	(638)	(1088)	15	1700	6	-731	-1231	188356	127276	60	0.2	2
01/04/18	to	02/02/18	02/05/18	to	02/09/18	913	853	2	1138	1	-225	-225	189269	128129	70	3.2	2.8
01/11/18	to	02/09/18	02/12/18	to	02/16/18	(419)	(479)	2	438	1	-856	-856	188850	127650	50	3.4	3.6
01/18/18	to	02/16/18	02/19/18	to	02/23/18	(1106)	(1256)	5	381	2	-838	-1488	187744	126394	40	0.2	2.6
01/25/18	to	02/23/18	02/26/18	to	03/02/18	863	833	1	863	1	0	0	188607	127227	50	3.4	3.6
02/01/18	to	03/02/18	03/05/18	to	03/09/18	156	66	3	1219	2	-1063	-1063	188763	127293	30	3.4	3.2
02/08/18	to	03/09/18	03/12/18	to	03/16/18	(331)	(361)	1	0	0	-331	-331	188432	126932	60	0.2	3.4
02/15/18	to	03/16/18	03/19/18	to	03/23/18	431	401	1	431	1	0	0	188863	127333	70	2.6	2.4
02/22/18	to	03/23/18	03/26/18	to	03/30/18	(1219)	(1249)	1	0	0	-1219	-1219	187644	126084	60	1	2.8
03/01/18	to	03/30/18	04/02/18	to	04/06/18	(581)	(671)	3	175	1	-719	-756	187063	125413	50	0.2	3
03/08/18	to	04/06/18	04/09/18	to	04/13/18	669	639	1	669	1	0	0	187732	126052	50	0.4	3
03/15/18	to	04/13/18	04/16/18	to	04/20/18	938	908	1	938	1	0	0	188670	126960	70	2	1.4
03/22/18	to	04/20/18	04/23/18	to	04/27/18	1144	964	6	1938	4	-444	-700	189814	127924	60	1.4	1.4

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

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

b = 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 EC from 4/1/2010 to 4/28/2017 to generate this table.

EC1min 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 √N. So if we multiply the Velocity by the √N, the Velocities for different N should have the same SDs and ranges. Below are the results for multiplying the Velocity by √N.

EC1min 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*√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 vup and vdn from 0.2 to 3.6 standard deviations for all N.