Trading the 24hr Euro 1 min bar Futures With The Least Squares Velocity Strategy 4/1/2010 -4/28/2017

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In previous working papers 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 or 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 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 Least Squares Velocity

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 straight line through those twenty prices such that the sum of all the squared differences between the prices at each time interval and the straight line that is being fit to the data is minimized? This is called the "Least Squares Fit" line of the data (also referred to as the linear regression line). This mathematical technique is available in most of today's technical analysis software.

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 at easy way to visualize dy/dt, the derivative of y with respect to t, 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. With a lot of strategies this back and forth movement creates many false buy and sell signals. However, using the least squares velocity, we can filter many of the small 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

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

In order to gain confidence that our input parameter selection method using the optimization output of the in-sample data will produce profits, we must test the input parameters we found in the in-sample section on out-of-sample data. In addition, we must perform the in-sample/out-of-sample analysis many times. Why not just do the out-of-sample analysis once or just 10 times? Well just as in Poker or any card game, where there is considerable variation in luck from hand to hand, walk forward out-of-sample analysis give considerable variation in 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 4/28/2017with 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 data.

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 an *example* of a better and more complicated ***filter*** that was used on the in-sample sections. **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 5 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 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. **Row 3** of the sample output in **Figure 3** shows the results of the filter discussed above. Commissions and slippage for the EC were estimated at $30 round trip for one contract. A total of 28800 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 **($415.3)** with a bootstrap standard deviation of **$106.9**. (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 138016/357=386.6). The probability of obtaining our filters average weekly net profit **of 386.6** is $\mathbf{3.23x10^{-14}}$ which is **7.5** 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 **$386.6** is
$[1-(1-\mathbf{3.23x10^{-14}})^{28800}]\sim\ \mathbf{28800}\text{x}\ \mathbf{3.23x10^{-14}} = \mathbf{9.3x10^{-10}} \sim \mathbf{0}$ where **28800** is the total number of different filters we looked at in this run. This number is much less than one so it is improbable that our result was due to pure chance.

Results

Table 1 below presents a table of the 364 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(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.

Figure 2 presents the out-of-sample 1 minute bar chart of EC for 2/22/17 to 2/24/17 with the LSQV 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 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 64%, 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 1.81.

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.

In Figure 1, which 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 $138,016 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 -$7950 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.

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 32 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 10/8/2010 to 4/21/2017

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

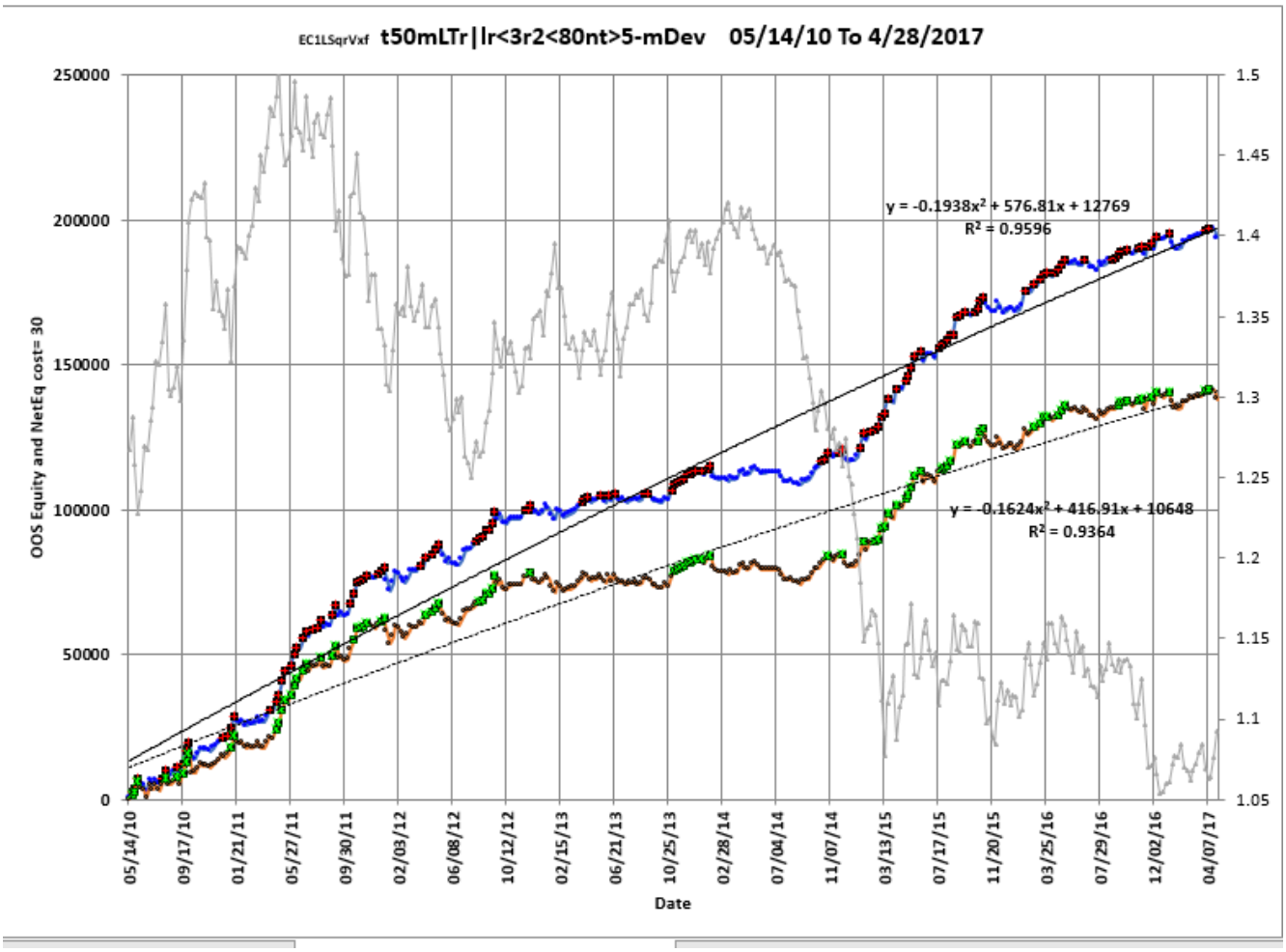

Figure 2 Walk Forward Out-Of-Sample Performance Summary for EC 1 min bars Least Squares Velocity Strategy 1 minute bar chart from 2/22/17-2/24/2017

Figure 3 **Partial output of the Walk Forward Metric Explorer (WFME v8)**
EC-Mini 1 min bars Least Squares Velocity System

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	EC1LSqrVxf	s05/14/10	e04/28/17	#364	AnyTnp						a(415.3)	s106.9	f28800								c=$30			
2	Filter-Metric	toGP	toNP	aoGP	aoTr	ao#T	oW|oL	%Wtr	%P	t	LLtr	LLp	eqDD	wpr	lpr	#	eqTrn	eqV^2	Dev^2	KTau	eqR2	Blw	BE	Prob
3	t50mLTr|lr<3r2<80nt>5-mDev	193816	138016	543	104.2	5.2	1.81	44	64	5.72	-2938	-5963	-7950	12	4	357	506	436	11087	91	96	36	44	3.23E-14
4	b50mDev|lr<5r2<90nt>5-mDev	185184	129954	531	100.6	5.3	1.77	44	62	5.39	-3763	-6525	-12202	10	5	349	440	93	14700	83	91	64	48	8.78E-14
5	t50mLTr|lr<3r2<70nt>5-mDev	185426	129146	517	98.8	5.2	1.84	43	62	5.57	-2938	-3988	-7613	12	4	359	473	187	12522	90	94	37	46	2.12E-13
6	b50mDev|lr<5r2<80nt>5-mDev	183603	127593	523	98.3	5.3	1.8	44	62	5.25	-3763	-6525	-15663	12	5	351	429	134	13889	81	91	64	51	1.63E-13
7	t50mLTr|lr<3r2<80nt>10-mDev	188000	127400	516	93.1	5.5	1.84	43	63	5.41	-2938	-5963	-14353	10	5	364	472	435	10465	90	96	25	50	4.13E-13
8	b50mDev|lr<5r2<90nt>10-mDev	189349	126259	522	90.0	5.8	1.8	44	64	5.3	-3763	-6525	-16938	10	6	363	433	39	16498	82	88	43	52	4.80E-13
9	b50mDev|lr<5r2<80nt>10-mDev	184217	121427	507	88.0	5.8	1.82	43	63	5.14	-3763	-6525	-16938	12	6	363	426	79	15202	82	90	42	55	1.18E-12
10	b50mDev|lr<4r2<90nt>5-mDev	165654	119424	476	107.5	4.4	1.68	45	61	4.72	-3763	-6525	-15912	9	5	348	388	68	14050	77	89	63	63	6.57E-13

The WFME Filter Output Columns are defined as follows:

Row 1 EC1LSqVxf is the strategy abbreviation, First OOS Week End Date(5/14/2010), Last OOS Week End Date(4/28/2017), **Number of weeks**(#364) **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=$30).

Filter = The filter that was run. Row 3 filter **t50mLTr|lr<3r2<80nt>5mDev**

The filter produced the following average 364 week statistics on row 3.

toGP = Total out-of-sample(oos) gross profit for these 364 weeks.

toNP = Total out-of-sample net profit. toNP=toGP **–** (Number of trade weeks)*ao#T*Cost

aoGP = Average oos gross profit for the 364 weeks

aoTr = Average oos gross profit per trade

ao#T = Average number of oos trades per week

oW|oL= the ratio of the average winning oos trades to average losing oos trades.

%Wtr = The percentage of oos trades that were profitable

%P = The percentage of oos weeks that were profitable

t = The student t statistic for the 364 weekly oos profits. The higher the t statistic the higher the probability that this result was not due to pure chance

LLtr = The largest losing oos trade in the whole period

LLp = The largest losing oos period(week)

eqDD = The oos equity drawdown

wpr = The largest number of consecutive winning oos weeks in a row

lpr = The largest number of consecutive 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^2 = The ending velocity of 2nd order polynomial that is fit to the equity curve

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

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)

EqR2 = The correlation coefficient(r^2) of a straight line fit to the equity curve

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.

Prob = the probability that the filter's tOnpNet 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*20**.
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	ollt	odd	EQ	NetEq	N	vup	vdn
04/08/10	to	05/07/10	05/09/10	to	05/14/10	625	85	18	-1275	-2763	625	85	40	2.4	2.8
04/15/10	to	05/14/10	05/16/10	to	05/21/10	1938	1698	8	-1450	-2750	2563	1783	70	2.8	3.4
04/22/10	to	05/21/10	05/23/10	to	05/28/10	1275	945	11	-788	-2175	3838	2728	60	3.2	2.4
04/29/10	to	05/28/10	05/30/10	to	06/04/10	3288	3198	3	-713	-713	7126	5926	60	3.4	2.4
05/06/10	to	06/04/10	06/06/10	to	06/11/10	-2088	-2238	5	-1188	-3063	5038	3688	70	3.4	2.4
05/13/10	to	06/11/10	06/13/10	to	06/18/10	-38	-218	6	-638	-975	5000	3470	70	3.4	3
05/20/10	to	06/18/10	06/20/10	to	06/25/10	-2513	-2783	9	-1000	-3563	2487	687	50	1.6	3
05/27/10	to	06/25/10	06/27/10	to	07/02/10	4050	3990	2	0	0	6537	4677	60	2.6	3.4
06/03/10	to	07/02/10	07/04/10	to	07/09/10	-1150	-1210	2	-588	-1150	5387	3467	50	3.2	2.2
06/10/10	to	07/09/10	07/11/10	to	07/16/10	1463	1373	3	-963	-963	6850	4840	60	3.4	2.6
06/17/10	to	07/16/10	07/18/10	to	07/23/10	-1475	-1835	12	-963	-1913	5375	3005	60	3.2	1.2
06/24/10	to	07/23/10	07/25/10	to	07/30/10	2038	1888	5	-13	-13	7413	4893	60	0.4	3.2
07/01/10	to	07/30/10	08/01/10	to	08/06/10	2700	2550	5	-13	-13	10113	7443	50	1.2	3.4
07/08/10	to	08/06/10	08/08/10	to	08/13/10	-2213	-2513	10	-2500	-4125	7900	4930	60	1.4	3.4
07/15/10	to	08/13/10	08/15/10	to	08/20/10	463	343	4	-575	-875	8363	5273	70	1.8	3
07/22/10	to	08/20/10	08/22/10	to	08/27/10	1100	1010	3	-738	-738	9463	6283	60	1.6	3.4
07/29/10	to	08/27/10	08/29/10	to	09/03/10	1625	1595	1	0	0	11088	7878	50	0.2	3.2
08/05/10	to	09/03/10	09/05/10	to	09/10/10	-2400	-2730	11	-750	-2400	8688	5148	70	0.2	2.2
08/12/10	to	09/10/10	09/12/10	to	09/17/10	3675	3525	5	-613	-825	12363	8673	40	0.6	3.4
08/19/10	to	09/17/10	09/19/10	to	09/24/10	4488	4278	7	-638	-938	16851	12951	50	1.2	2.8
08/26/10	to	09/24/10	09/26/10	to	10/01/10	2938	2728	7	-788	-788	19789	15679	40	1.2	3.6
09/02/10	to	10/01/10	10/03/10	to	10/08/10	-5963	-6533	19	-1675	-6738	13826	9146	40	3.2	0.4
09/09/10	to	10/08/10	10/10/10	to	10/15/10	400	160	8	-900	-1800	14226	9306	60	3	2
09/16/10	to	10/15/10	10/17/10	to	10/22/10	1613	1463	5	-288	-288	15839	10769	70	3	1.6
09/23/10	to	10/22/10	10/24/10	to	10/29/10	1538	1388	5	-575	-988	17377	12157	60	3	2
09/30/10	to	10/29/10	10/31/10	to	11/05/10	-263	-503	8	-1263	-3263	17114	11654	70	3	1.4
10/07/10	to	11/05/10	11/07/10	to	11/12/10	388	118	9	-913	-1900	17502	11772	50	3	3
10/14/10	to	11/12/10	11/14/10	to	11/19/10	-838	-868	1	-838	-838	16664	10904	50	2.2	3.6
10/21/10	to	11/19/10	11/21/10	to	11/26/10	1075	1015	2	-2638	-2638	17739	11919	70	3.6	3.4
10/28/10	to	11/26/10	11/28/10	to	12/03/10	913	583	11	-1163	-2963	18652	12502	40	2.6	3.2
11/04/10	to	12/03/10	12/05/10	to	12/10/10	1013	983	1	0	0	19665	13485	60	3.6	3

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp$30	ont	ollt	odd	EQ	NetEq	N	vup	vdn
11/11/10	to	12/10/10	12/12/10	to	12/17/10	1888	1798	3	-2113	-2113	21553	15283	60	3.2	1.6
11/18/10	to	12/17/10	12/19/10	to	12/24/10	-788	-908	4	-663	-1088	20765	14375	60	3.4	3
11/25/10	to	12/24/10	12/26/10	to	12/31/10	1375	1195	6	-1013	-1850	22140	15570	40	3.4	2.2
12/02/10	to	12/31/10	01/02/11	to	01/07/11	2438	2168	9	-913	-2813	24578	17738	40	3.4	1.8
12/09/10	to	01/07/11	01/09/11	to	01/14/11	4200	4110	3	-413	-413	28778	21848	50	3.4	3.6
12/16/10	to	01/14/11	01/16/11	to	01/21/11	-2088	-2148	2	-2938	-2938	26690	19700	50	3.4	3.6
12/23/10	to	01/21/11	01/23/11	to	01/28/11	-100	-430	11	-288	-813	26590	19270	30	1	3.4
12/30/10	to	01/28/11	01/30/11	to	02/04/11	463	253	7	-725	-1788	27053	19523	30	1.8	3.6
01/06/11	to	02/04/11	02/06/11	to	02/11/11	-1550	-1760	7	-863	-2875	25503	17763	30	2.8	2
01/13/11	to	02/11/11	02/13/11	to	02/18/11	825	585	8	-525	-1163	26328	18348	40	1.8	3.6
01/20/11	to	02/18/11	02/20/11	to	02/25/11	-500	-710	7	-1163	-1950	25828	17638	50	3.4	0.4
01/27/11	to	02/25/11	02/27/11	to	03/04/11	500	380	4	-538	-538	26328	18018	30	3.4	3
02/03/11	to	03/04/11	03/06/11	to	03/11/11	1975	1825	5	-138	-138	28303	19843	40	3	0.4
02/10/11	to	03/11/11	03/13/11	to	03/18/11	-1900	-2110	7	-975	-2625	26403	17733	30	3.4	2.2
02/17/11	to	03/18/11	03/20/11	to	03/25/11	275	65	7	-388	-1063	26678	17798	50	2.6	1
02/24/11	to	03/25/11	03/27/11	to	04/01/11	2038	1918	4	-1050	-1050	28716	19716	50	3.2	1.8
03/03/11	to	04/01/11	04/03/11	to	04/08/11	2013	1833	6	-500	-800	30729	21549	60	2.2	2
03/10/11	to	04/08/11	04/10/11	to	04/15/11	-438	-648	7	-775	-1575	30291	20901	50	3	1
03/17/11	to	04/15/11	04/17/11	to	04/22/11	3338	3188	5	-963	-1250	33629	24089	50	1.6	2.6
03/24/11	to	04/22/11	04/24/11	to	04/29/11	2463	2373	3	-238	-238	36092	26462	50	0.4	3.6
03/31/11	to	04/29/11	05/01/11	to	05/06/11	4813	4603	7	-525	-1225	40905	31065	70	3	0.4
04/07/11	to	05/06/11	05/08/11	to	05/13/11	3700	3310	13	-825	-1263	44605	34375	70	2.6	0.6
04/14/11	to	05/13/11	05/15/11	to	05/20/11	-825	-885	2	-1175	-1175	43780	33490	50	3.6	3.6
04/21/11	to	05/20/11	05/22/11	to	05/27/11	2450	2300	5	-300	-300	46230	35790	50	0.8	3.6
04/28/11	to	05/27/11	05/29/11	to	06/03/11	3700	3670	1	0	0	49930	39460	70	3	3.6
05/05/11	to	06/03/11	06/05/11	to	06/10/11	2275	2245	1	0	0	52205	41705	70	2.8	3.4
05/12/11	to	06/10/11	06/12/11	to	06/17/11	-375	-585	7	-1550	-2813	51830	41120	50	0.6	3.4
05/19/11	to	06/17/11	06/19/11	to	06/24/11	3763	3343	14	-663	-888	55593	44463	20	2.6	3.6
05/26/11	to	06/24/11	06/26/11	to	07/01/11	2538	2178	12	-638	-838	58131	46641	70	0.8	2
06/02/11	to	07/01/11	07/03/11	to	07/08/11	-1813	-2503	23	-650	-2975	56318	44138	50	0.8	2
06/09/11	to	07/08/11	07/10/11	to	07/15/11	2538	2208	11	-1163	-2650	58856	46346	70	3.2	0.2
06/16/11	to	07/15/11	07/17/11	to	07/22/11	-525	-735	7	-1200	-1750	58331	45611	70	3.2	0.8
06/23/11	to	07/22/11	07/24/11	to	07/29/11	763	553	7	-1263	-1263	59094	46164	70	3.2	0.6
06/30/11	to	07/29/11	07/31/11	to	08/05/11	2975	2585	13	-1088	-1513	62069	48749	60	3.4	1
07/07/11	to	08/05/11	08/07/11	to	08/12/11	-2650	-3190	18	-1075	-4913	59419	45559	60	2.6	2.6
07/14/11	to	08/12/11	08/14/11	to	08/19/11	800	590	7	-1250	-1413	60219	46149	70	3.2	1.6
07/21/11	to	08/19/11	08/21/11	to	08/26/11	-313	-403	3	-800	-1213	59906	45746	70	3.6	2.8
07/28/11	to	08/26/11	08/28/11	to	09/02/11	3700	3670	1	0	0	63606	49416	70	3.6	1.6
08/04/11	to	09/02/11	09/04/11	to	09/09/11	3700	3550	5	-1113	-1750	67306	52966	70	3.2	1.4
08/11/11	to	09/09/11	09/11/11	to	09/16/11	-3988	-4438	15	-1313	-4800	63318	48528	70	3	0.6
08/18/11	to	09/16/11	09/18/11	to	09/23/11	650	200	15	-875	-2050	63968	48728	70	3	1.2
08/25/11	to	09/23/11	09/25/11	to	09/30/11	-738	-1038	10	-2038	-3850	63230	47690	40	3	3.4
09/01/11	to	09/30/11	10/02/11	to	10/07/11	638	488	5	-825	-825	63868	48178	70	2.4	3.6
09/08/11	to	10/07/11	10/09/11	to	10/14/11	4000	3910	3	-200	-200	67868	52088	70	2.6	3.6
09/15/11	to	10/14/11	10/16/11	to	10/21/11	3175	2965	7	-963	-1275	71043	55053	70	2.6	3.6
09/22/11	to	10/21/11	10/23/11	to	10/28/11	4200	4110	3	0	0	75243	59163	70	1	3.6
09/29/11	to	10/28/11	10/30/11	to	11/04/11	375	165	7	-2013	-3863	75618	59328	60	3.6	3.6
10/06/11	to	11/04/11	11/06/11	to	11/11/11	763	583	6	-1400	-2275	76381	59911	50	3.2	3.6
10/13/11	to	11/11/11	11/13/11	to	11/18/11	1050	930	4	-463	-825	77431	60841	60	3.2	3.6

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp$30	ont	ollt	odd	EQ	NetEq	N	vup	vdn
10/20/11	to	11/18/11	11/20/11	to	11/25/11	-63	-153	3	-1513	-2113	77368	60688	60	3.2	3.6
10/27/11	to	11/25/11	11/27/11	to	12/02/11	-738	-918	6	-1238	-2100	76630	59770	50	3.6	0.6
11/03/11	to	12/02/11	12/04/11	to	12/09/11	-363	-633	9	-713	-1113	76267	59137	40	2	3.2
11/10/11	to	12/09/11	12/11/11	to	12/16/11	1363	1123	8	-650	-938	77630	60260	40	1.8	3.2
11/17/11	to	12/16/11	12/18/11	to	12/23/11	1188	1098	3	-75	-75	78818	61358	70	1.2	3.4
11/24/11	to	12/23/11	12/25/11	to	12/30/11	1025	935	3	-825	-825	79843	62293	50	1.6	3.2
12/01/11	to	12/30/11	01/01/12	to	01/06/12	-4300	-4510	7	-1463	-4300	75543	57783	30	1	3.6
12/08/11	to	01/06/12	01/08/12	to	01/13/12	-3650	-4190	18	-1075	-4988	71893	53593	60	1.4	2
12/15/11	to	01/13/12	01/15/12	to	01/20/12	2800	2650	5	-400	-400	74693	56243	70	0.2	3.6
12/22/11	to	01/20/12	01/22/12	to	01/27/12	3750	3690	2	-150	-150	78443	59933	70	0.6	3.4
12/29/11	to	01/27/12	01/29/12	to	02/03/12	-575	-785	7	-750	-2063	77868	59148	30	3.2	1.8
01/05/12	to	02/03/12	02/05/12	to	02/10/12	-1513	-1873	12	-1138	-3675	76355	57275	30	1.8	3
01/12/12	to	02/10/12	02/12/12	to	02/17/12	-1613	-1703	3	-1938	-2163	74742	55572	40	2	3.6
01/19/12	to	02/17/12	02/19/12	to	02/24/12	1600	1510	3	-613	-813	76342	57082	70	1.2	2.8
01/26/12	to	02/24/12	02/26/12	to	03/02/12	2688	2598	3	-200	-313	79030	59680	40	3.6	1
02/02/12	to	03/02/12	03/04/12	to	03/09/12	-263	-323	2	-650	-650	78767	59357	60	1.6	3.6
02/09/12	to	03/09/12	03/11/12	to	03/16/12	113	53	2	-663	-663	78880	59410	60	2.2	2.2
02/16/12	to	03/16/12	03/18/12	to	03/23/12	1775	1625	5	-200	-263	80655	61035	70	0.4	2.6
02/23/12	to	03/23/12	03/25/12	to	03/30/12	-638	-698	2	-1175	-1175	80017	60337	60	2.2	3.4
03/01/12	to	03/30/12	04/01/12	to	04/06/12	3538	3448	3	-225	-225	83555	63785	40	3.2	0.8
03/08/12	to	04/06/12	04/08/12	to	04/13/12	-225	-255	1	-225	-225	83330	63530	40	0.2	3.2
03/15/12	to	04/13/12	04/15/12	to	04/20/12	1400	1310	3	-313	-313	84730	64840	50	1.6	3.2
03/22/12	to	04/20/12	04/22/12	to	04/27/12	1400	1310	3	0	0	86130	66150	40	1.2	3.2
03/29/12	to	04/27/12	04/29/12	to	05/04/12	1750	1660	3	-88	-88	87880	67810	60	2.6	0.2
04/05/12	to	05/04/12	05/06/12	to	05/11/12	-1913	-2033	4	-950	-1925	85967	65777	20	2.4	3.6
04/12/12	to	05/11/12	05/13/12	to	05/18/12	-1813	-1903	3	-1488	-1813	84154	63874	60	0.2	3.4
04/19/12	to	05/18/12	05/20/12	to	05/25/12	-2463	-2643	6	-1413	-2463	81691	61231	30	2.4	3.4
04/26/12	to	05/25/12	05/27/12	to	06/01/12	975	885	3	-1163	-1163	82666	62116	60	2.2	3.4
05/03/12	to	06/01/12	06/03/12	to	06/08/12	-1363	-1513	5	-1088	-1388	81303	60603	30	2.4	3.6
05/10/12	to	06/08/12	06/10/12	to	06/15/12	-188	-218	1	-188	-188	81115	60385	70	2.6	3.6
05/17/12	to	06/15/12	06/17/12	to	06/22/12	-313	-373	2	-1163	-1163	80802	60012	70	3.4	3.6
05/24/12	to	06/22/12	06/24/12	to	06/29/12	2050	1960	3	-738	-738	82852	61972	30	2.6	3.6
05/31/12	to	06/29/12	07/01/12	to	07/06/12	2850	2820	1	0	0	85702	64792	70	2.8	2.4
06/07/12	to	07/06/12	07/08/12	to	07/13/12	438	348	3	-200	-200	86140	65140	50	3	0.2
06/14/12	to	07/13/12	07/15/12	to	07/20/12	400	280	4	-425	-738	86540	65420	70	2	3.2
06/21/12	to	07/20/12	07/22/12	to	07/27/12	1200	1050	5	-500	-1063	87740	66470	50	2.6	3.2
06/28/12	to	07/27/12	07/29/12	to	08/03/12	1250	920	11	-638	-1175	88990	67390	50	0.2	2
07/05/12	to	08/03/12	08/05/12	to	08/10/12	1050	930	4	-288	-288	90040	68320	40	3.4	0.6
07/12/12	to	08/10/12	08/12/12	to	08/17/12	538	388	5	-25	-25	90578	68708	70	0.2	2.8
07/19/12	to	08/17/12	08/19/12	to	08/24/12	2213	2183	1	0	0	92791	70891	70	0.4	2.8
07/26/12	to	08/24/12	08/26/12	to	08/31/12	363	213	5	-225	-300	93154	71104	70	0.6	2.2
08/02/12	to	08/31/12	09/02/12	to	09/07/12	2025	1875	5	-913	-963	95179	72979	50	1.8	2.4
08/09/12	to	09/07/12	09/09/12	to	09/14/12	4138	4108	1	0	0	99317	77087	40	2.8	2.4
08/16/12	to	09/14/12	09/16/12	to	09/21/12	-2600	-2810	7	-2100	-2750	96717	74277	30	0.4	3.4
08/23/12	to	09/21/12	09/23/12	to	09/28/12	1325	1055	9	-375	-425	98042	75332	60	1.8	1
08/30/12	to	09/28/12	09/30/12	to	10/05/12	-2713	-2803	3	-1513	-2713	95329	72529	30	3.6	1
09/06/12	to	10/05/12	10/07/12	to	10/12/12	-125	-155	1	-125	-125	95204	72374	70	3.6	2.4
09/13/12	to	10/12/12	10/14/12	to	10/19/12	1350	1320	1	0	0	96554	73694	60	0.6	2.8
09/20/12	to	10/19/12	10/21/12	to	10/26/12	238	208	1	0	0	96792	73902	60	3.6	2.8

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp$30	ont	ollt	odd	EQ	NetEq	N	vup	vdn
09/27/12	to	10/26/12	10/28/12	to	11/02/12							73902	60	3.6	3
10/04/12	to	11/02/12	11/04/12	to	11/09/12	200	110	3	-463	-713	96992	74012	20	3.2	3.4
10/11/12	to	11/09/12	11/11/12	to	11/16/12	150	60	3	-188	-225	97142	74072	20	1.4	3.4
10/18/12	to	11/16/12	11/18/12	to	11/23/12	2825	2675	5	-400	-613	99967	76747	20	1.4	2.8
10/25/12	to	11/23/12	11/25/12	to	11/30/12	38	8	1	0	0	100005	76755	30	1.8	3.4
11/01/12	to	11/30/12	12/02/12	to	12/07/12	1788	1698	3	-50	-50	101793	78453	20	2	3
11/08/12	to	12/07/12	12/09/12	to	12/14/12	-2900	-3020	4	-2113	-3263	98893	75433	40	2.8	2.2
11/15/12	to	12/14/12	12/16/12	to	12/21/12	138	18	4	-575	-975	99031	75451	50	2	2.6
11/22/12	to	12/21/12	12/23/12	to	12/28/12	-800	-1010	7	-425	-900	98231	74441	30	2.8	0.2
11/29/12	to	12/28/12	12/30/12	to	01/04/13	988	928	2	-625	-625	99219	75369	60	2.8	2.4
12/06/12	to	01/04/13	01/06/13	to	01/11/13	2113	2083	1	0	0	101332	77452	50	3	3
12/13/12	to	01/11/13	01/13/13	to	01/18/13	-863	-1313	15	-575	-1363	100469	76139	20	0.8	2.6
12/20/12	to	01/18/13	01/20/13	to	01/25/13	-2288	-2738	15	-725	-2288	98181	73401	20	3.2	0.6
12/27/12	to	01/25/13	01/27/13	to	02/01/13	-1613	-1943	11	-2163	-3588	96568	71458	20	3.2	1
01/03/13	to	02/01/13	02/03/13	to	02/08/13	2988	2778	7	-388	-413	99556	74236	40	3.2	1.4
01/10/13	to	02/08/13	02/10/13	to	02/15/13	-575	-725	5	-675	-1588	98981	73511	60	3.4	0.6
01/17/13	to	02/15/13	02/17/13	to	02/22/13	-1563	-1893	11	-1163	-2775	97418	71618	30	0.8	2.8
01/24/13	to	02/22/13	02/24/13	to	03/01/13	700	550	5	-550	-1088	98118	72168	60	1.4	3.6
01/31/13	to	03/01/13	03/03/13	to	03/08/13	550	460	3	-13	-13	98668	72628	40	1.4	2.8
02/07/13	to	03/08/13	03/10/13	to	03/15/13	500	410	3	-888	-888	99168	73038	40	1.2	3
02/14/13	to	03/15/13	03/17/13	to	03/22/13	388	268	4	-338	-675	99556	73306	40	1.4	3.4
02/21/13	to	03/22/13	03/24/13	to	03/29/13	1638	1548	3	-863	-1000	101194	74854	50	3.2	1.2
02/28/13	to	03/29/13	03/31/13	to	04/05/13	1388	1238	5	-400	-1213	102582	76092	50	0.2	3
03/07/13	to	04/05/13	04/07/13	to	04/12/13	1475	1445	1	0	0	104057	77537	40	1.2	2.8
03/14/13	to	04/12/13	04/14/13	to	04/19/13	75	-345	14	-625	-1550	104132	77192	70	0.8	2
03/21/13	to	04/19/13	04/21/13	to	04/26/13	-1650	-1800	5	-1163	-1988	102482	75392	60	2.6	2.4
03/28/13	to	04/26/13	04/28/13	to	05/03/13	725	575	5	-538	-725	103207	75967	70	0.2	3.6
04/04/13	to	05/03/13	05/05/13	to	05/10/13	163	73	3	-600	-988	103370	76040	60	3	2.2
04/11/13	to	05/10/13	05/12/13	to	05/17/13	1413	1383	1	0	0	104783	77423	60	3.6	2.2
04/18/13	to	05/17/13	05/19/13	to	05/24/13	-1263	-1383	4	-1088	-1600	103520	76040	50	3.4	1.8
04/25/13	to	05/24/13	05/26/13	to	05/31/13	-1050	-1170	4	-800	-1163	102470	74870	40	3.2	3.2
05/02/13	to	05/31/13	06/02/13	to	06/07/13	2400	2310	3	-163	-163	104870	77180	50	0.6	3.4
05/09/13	to	06/07/13	06/09/13	to	06/14/13	-1900	-2050	5	-650	-1950	102970	75130	30	3	3
05/16/13	to	06/14/13	06/16/13	to	06/21/13	2350	2140	7	-388	-388	105320	77270	20	2.6	2
05/23/13	to	06/21/13	06/23/13	to	06/28/13	-1550	-1940	13	-988	-2150	103770	75330	40	0.2	2.2
05/30/13	to	06/28/13	06/30/13	to	07/05/13	-538	-598	2	-1613	-1613	103232	74732	60	1.2	3.6
06/06/13	to	07/05/13	07/07/13	to	07/12/13	350	290	2	-1525	-1525	103582	75022	50	2.2	3.4
06/13/13	to	07/12/13	07/14/13	to	07/19/13	-988	-1018	1	-988	-988	102594	74004	60	3.2	0.4
06/20/13	to	07/19/13	07/21/13	to	07/26/13	475	445	1	0	0	103069	74449	50	2.4	3.6
06/27/13	to	07/26/13	07/28/13	to	08/02/13	388	28	12	-300	-875	103457	74477	40	1.6	1.4
07/04/13	to	08/02/13	08/04/13	to	08/09/13	363	333	1	0	0	103820	74810	60	2	3.2
07/11/13	to	08/09/13	08/11/13	to	08/16/13	-713	-833	4	-875	-1663	103107	73977	60	2.6	2.6
07/18/13	to	08/16/13	08/18/13	to	08/23/13	525	495	1	0	0	103632	74472	30	0.4	3.4
07/25/13	to	08/23/13	08/25/13	to	08/30/13	1850	1820	1	0	0	105482	76292	70	3.6	0.8
08/01/13	to	08/30/13	09/01/13	to	09/06/13	88	-2	3	-563	-700	105570	76290	30	3.6	0.2
08/08/13	to	09/06/13	09/08/13	to	09/13/13	-525	-555	1	-525	-525	105045	75735	50	3.6	1.4
08/15/13	to	09/13/13	09/15/13	to	09/20/13	-1875	-1995	4	-1663	-2025	103170	73740	70	3.6	1.4
08/22/13	to	09/20/13	09/22/13	to	09/27/13	38	8	1	0	0	103208	73748	40	3.2	0.6
08/29/13	to	09/27/13	09/29/13	to	10/04/13	-725	-815	3	-625	-725	102483	72933	40	3	2.6

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp$30	ont	ollt	odd	EQ	NetEq	N	vup	vdn
09/05/13	to	10/04/13	10/06/13	to	10/11/13							72933	40	3	3
09/12/13	to	10/11/13	10/13/13	to	10/18/13	1350	1200	5	-875	-913	103833	74133	30	2.6	2
09/19/13	to	10/18/13	10/20/13	to	10/25/13	-550	-610	2	-688	-688	103283	73523	50	2.4	1.4
09/26/13	to	10/25/13	10/27/13	to	11/01/13	3400	3310	3	-213	-363	106683	76833	50	2.4	1.4
10/03/13	to	11/01/13	11/03/13	to	11/08/13	2425	2275	5	-1000	-1325	109108	79108	50	2.4	1.2
10/10/13	to	11/08/13	11/10/13	to	11/15/13	175	115	2	-475	-475	109283	79223	60	2.6	3.2
10/17/13	to	11/15/13	11/17/13	to	11/22/13	963	903	2	-125	-125	110246	80126	70	2	3.6
10/24/13	to	11/22/13	11/24/13	to	11/29/13	525	495	1	0	0	110771	80621	50	1.2	2.6
10/31/13	to	11/29/13	12/01/13	to	12/06/13	1363	1333	1	0	0	112134	81954	60	2.6	3.6
11/07/13	to	12/06/13	12/08/13	to	12/13/13	75	45	1	0	0	112209	81999	50	2.4	1.2
11/14/13	to	12/13/13	12/15/13	to	12/20/13	388	298	3	-200	-200	112597	82297	60	0.2	2
11/21/13	to	12/20/13	12/22/13	to	12/27/13	750	720	1	0	0	113347	83017	60	0.4	2.2
11/28/13	to	12/27/13	12/29/13	to	01/03/14	-325	-445	4	-625	-650	113022	82572	60	0.8	2
12/05/13	to	01/03/14	01/05/14	to	01/10/14	563	473	3	-425	-600	113585	83045	70	0.4	2.2
12/12/13	to	01/10/14	01/12/14	to	01/17/14	-1638	-1788	5	-763	-1638	111947	81257	70	0.4	2.2
12/19/13	to	01/17/14	01/19/14	to	01/24/14	1900	1750	5	-163	-163	113847	83007	70	0.2	1.6
12/26/13	to	01/24/14	01/26/14	to	01/31/14	1163	833	11	-325	-850	115010	83840	50	1	1.2
01/02/14	to	01/31/14	02/02/14	to	02/07/14	-3625	-4015	13	-575	-3625	111385	79825	50	2.2	0.8
01/09/14	to	02/07/14	02/09/14	to	02/14/14	-750	-840	3	-488	-750	110635	78985	30	3.6	1
01/16/14	to	02/14/14	02/16/14	to	02/21/14	-300	-480	6	-213	-350	110335	78505	20	1.2	2.4
01/23/14	to	02/21/14	02/23/14	to	02/28/14	225	75	5	-750	-1613	110560	78580	30	1.2	2.4
01/30/14	to	02/28/14	03/02/14	to	03/07/14	88	-2	3	-475	-475	110648	78578	50	3.6	1.4
02/06/14	to	03/07/14	03/09/14	to	03/14/14	-725	-935	7	-600	-1138	109923	77643	60	1.6	0.6
02/13/14	to	03/14/14	03/16/14	to	03/21/14	1163	1133	1	0	0	111086	78776	70	3.2	1
02/20/14	to	03/21/14	03/23/14	to	03/28/14	-763	-853	3	-900	-1513	110323	77923	70	3.4	1
02/27/14	to	03/28/14	03/30/14	to	04/04/14	425	395	1	0	0	110748	78318	50	2.8	1.4
03/06/14	to	04/04/14	04/06/14	to	04/11/14	2288	2258	1	0	0	113036	80576	60	0.2	2.6
03/13/14	to	04/11/14	04/13/14	to	04/18/14	475	445	1	0	0	113511	81021	60	2.4	1.4
03/20/14	to	04/18/14	04/20/14	to	04/25/14	-1713	-1803	3	-663	-1713	111798	79218	60	2	1.4
03/27/14	to	04/25/14	04/27/14	to	05/02/14	725	545	6	-375	-375	112523	79763	70	1.8	0.4
04/03/14	to	05/02/14	05/04/14	to	05/09/14	1225	1165	2	-363	-363	113748	80928	70	1.8	3.6
04/10/14	to	05/09/14	05/11/14	to	05/16/14	725	695	1	0	0	114473	81623	20	3.6	1.6
04/17/14	to	05/16/14	05/18/14	to	05/23/14	-1075	-1105	1	-1075	-1075	113398	80518	40	0.8	2.6
04/24/14	to	05/23/14	05/25/14	to	05/30/14	-975	-1185	7	-325	-1063	112423	79333	70	1.4	0.2
05/01/14	to	05/30/14	06/01/14	to	06/06/14	250	-80	11	-375	-1325	112673	79253	60	1.4	0.2
05/08/14	to	06/06/14	06/08/14	to	06/13/14	213	183	1	0	0	112886	79436	70	2.8	2.2
05/15/14	to	06/13/14	06/15/14	to	06/20/14							79436	70	2.8	2.2
05/22/14	to	06/20/14	06/22/14	to	06/27/14							79436	40	3.4	1.8
05/29/14	to	06/27/14	06/29/14	to	07/04/14	25	-5	1	0	0	112911	79431	70	3.6	1.8
06/05/14	to	07/04/14	07/06/14	to	07/11/14	-225	-255	1	-225	-225	112686	79176	40	3.6	1.4
06/12/14	to	07/11/14	07/13/14	to	07/18/14	-1800	-1920	4	-1163	-1938	110886	77256	20	1	2.4
06/19/14	to	07/18/14	07/20/14	to	07/25/14	-1438	-1618	6	-1025	-1438	109448	75638	20	0.2	1.8
06/26/14	to	07/25/14	07/27/14	to	08/01/14	50	-40	3	-613	-613	109498	75598	50	0.2	1.2
07/03/14	to	08/01/14	08/03/14	to	08/08/14	525	495	1	0	0	110023	76093	60	1	2.6
07/10/14	to	08/08/14	08/10/14	to	08/15/14	-975	-1125	5	-625	-975	109048	74968	30	2.4	1.2
07/17/14	to	08/15/14	08/17/14	to	08/22/14							74968	60	1.4	2.4
07/24/14	to	08/22/14	08/24/14	to	08/29/14	-525	-615	3	-663	-663	108523	74353	40	2.2	2.2
07/31/14	to	08/29/14	08/31/14	to	09/05/14	1225	1195	1	0	0	109748	75548	70	1.8	2.4
08/07/14	to	09/05/14	09/07/14	to	09/12/14	150	120	1	0	0	109898	75668	60	2.2	3.6

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp$30	ont	ollt	odd	EQ	NetEq	N	vup	vdn
08/14/14	to	09/12/14	09/14/14	to	09/19/14	425	365	2	-700	-700	110323	76033	60	2.2	2.6
08/21/14	to	09/19/14	09/21/14	to	09/26/14	1913	1823	3	0	0	112236	77856	30	1.8	1.4
08/28/14	to	09/26/14	09/28/14	to	10/03/14	1888	1798	3	-100	-100	114124	79654	20	3.4	0.2
09/04/14	to	10/03/14	10/05/14	to	10/10/14	475	-155	21	-313	-1025	114599	79499	20	1.8	1.8
09/11/14	to	10/10/14	10/12/14	to	10/17/14	2063	1733	11	-750	-788	116662	81232	40	0.6	2
09/18/14	to	10/17/14	10/19/14	to	10/24/14	888	858	1	0	0	117550	82090	60	3.6	1
09/25/14	to	10/24/14	10/26/14	to	10/31/14	2138	2048	3	-613	-625	119688	84138	60	3.2	0.6
10/02/14	to	10/31/14	11/02/14	to	11/07/14	-350	-380	1	-350	-350	119338	83758	60	3.6	3.6
10/09/14	to	11/07/14	11/09/14	to	11/14/14	-1400	-1550	5	-950	-1400	117938	82208	50	3.2	0.6
10/16/14	to	11/14/14	11/16/14	to	11/21/14	1363	1333	1	0	0	119301	83541	40	3.4	2
10/23/14	to	11/21/14	11/23/14	to	11/28/14	425	305	4	-325	-350	119726	83846	40	0.8	2.4
10/30/14	to	11/28/14	11/30/14	to	12/05/14	1125	975	5	-588	-975	120851	84821	70	3.4	0.2
11/06/14	to	12/05/14	12/07/14	to	12/12/14	-3288	-3438	5	-2063	-3288	117563	81383	20	3.6	2
11/13/14	to	12/12/14	12/14/14	to	12/19/14	-1013	-1253	8	-1188	-2050	116550	80130	40	3	2.4
11/20/14	to	12/19/14	12/21/14	to	12/26/14	475	385	3	-38	-38	117025	80515	20	3.4	0.4
11/27/14	to	12/26/14	12/28/14	to	01/02/15							80515	70	2.8	3
12/04/14	to	01/02/15	01/04/15	to	01/09/15	1213	1183	1	0	0	118238	81698	40	3.4	2.4
12/11/14	to	01/09/15	01/11/15	to	01/16/15	3013	2353	22	-463	-1100	121251	84051	50	1.6	0.4
12/18/14	to	01/16/15	01/18/15	to	01/23/15	4950	4890	2	0	0	126201	88941	70	3.2	2.4
12/25/14	to	01/23/15	01/25/15	to	01/30/15	-2138	-3128	33	-675	-2175	124063	85813	50	1.6	1.2
01/01/15	to	01/30/15	02/01/15	to	02/06/15	2838	2658	6	-925	-1475	126901	88471	40	2.6	2.4
01/08/15	to	02/06/15	02/08/15	to	02/13/15	-288	-378	3	-963	-1388	126613	88093	70	1.2	2.6
01/15/15	to	02/13/15	02/15/15	to	02/20/15	1150	1030	4	-75	-75	127763	89123	70	1.2	2.6
01/22/15	to	02/20/15	02/22/15	to	02/27/15	825	795	1	0	0	128588	89918	60	3.2	3.4
01/29/15	to	02/27/15	03/01/15	to	03/06/15	3625	3595	1	0	0	132213	93513	30	3.4	3.2
02/05/15	to	03/06/15	03/08/15	to	03/13/15	1138	688	15	-1113	-1925	133351	94201	20	3.2	2.8
02/12/15	to	03/13/15	03/15/15	to	03/20/15	5038	4648	13	-1088	-2313	138389	98849	30	2	3.6
02/19/15	to	03/20/15	03/22/15	to	03/27/15	-1200	-1410	7	-925	-1675	137189	97439	60	2.6	2.6
02/26/15	to	03/27/15	03/29/15	to	04/03/15	-213	-543	11	-650	-1725	136976	96896	60	2.6	0.8
03/05/15	to	04/03/15	04/05/15	to	04/10/15	4925	4895	1	0	0	141901	101791	70	2.6	0.6
03/12/15	to	04/10/15	04/12/15	to	04/17/15	-188	-578	13	-1063	-1188	141713	101213	60	2.6	1.4
03/19/15	to	04/17/15	04/19/15	to	04/24/15	-300	-450	5	-613	-1588	141413	100763	50	1.8	2.8
03/26/15	to	04/24/15	04/26/15	to	05/01/15	3313	3163	5	-250	-250	144726	103926	60	0.2	3.6
04/02/15	to	05/01/15	05/03/15	to	05/08/15	1163	953	7	-763	-1500	145889	104879	60	3	1.6
04/09/15	to	05/08/15	05/10/15	to	05/15/15	2838	2808	1	0	0	148727	107687	50	2.6	3.6
04/16/15	to	05/15/15	05/17/15	to	05/22/15	4188	4098	3	-338	-338	152915	111785	60	3	1.6
04/23/15	to	05/22/15	05/24/15	to	05/29/15	-138	-168	1	-138	-138	152777	111617	60	0.2	3.6
04/30/15	to	05/29/15	05/31/15	to	06/05/15	1938	1608	11	-1538	-2500	154715	113225	40	0.2	3.6
05/07/15	to	06/05/15	06/07/15	to	06/12/15	-3600	-3990	13	-1663	-3675	151115	109235	30	3.6	1
05/14/15	to	06/12/15	06/14/15	to	06/19/15	2650	2470	6	-63	-63	153765	111705	30	1.8	3.4
05/21/15	to	06/19/15	06/21/15	to	06/26/15	-88	-298	7	-550	-1088	153677	111407	40	2.4	2.4
05/28/15	to	06/26/15	06/28/15	to	07/03/15	-138	-438	10	-800	-1538	153539	110969	40	2.4	2.4
06/04/15	to	07/03/15	07/05/15	to	07/10/15	-1275	-1605	11	-525	-2275	152264	109364	20	3	2.4
06/11/15	to	07/10/15	07/12/15	to	07/17/15	3625	3595	1	0	0	155889	112959	60	3.6	3.6
06/18/15	to	07/17/15	07/19/15	to	07/24/15	1175	1085	3	-200	-200	157064	114044	40	1.4	3.4
06/25/15	to	07/24/15	07/26/15	to	07/31/15	600	360	8	-538	-800	157664	114404	20	3.6	1.8
07/02/15	to	07/31/15	08/02/15	to	08/07/15	788	578	7	-838	-838	158452	114982	60	0.6	3.2
07/09/15	to	08/07/15	08/09/15	to	08/14/15	1800	1770	1	0	0	160252	116752	50	0.2	3.6
07/16/15	to	08/14/15	08/16/15	to	08/21/15	88	-2	3	-1613	-1613	160340	116750	20	3.4	2.6

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp$30	ont	ollt	odd	EQ	NetEq	N	vup	vdn
07/23/15	to	08/21/15	08/23/15	to	08/28/15	6263	5723	18	-663	-1313	166603	122473	20	3.4	2.8
07/30/15	to	08/28/15	08/30/15	to	09/04/15	175	-275	15	-613	-2075	166778	122198	60	1.6	0.6
08/06/15	to	09/04/15	09/06/15	to	09/11/15	-200	-290	3	-938	-1075	166578	121908	40	3	2.2
08/13/15	to	09/11/15	09/13/15	to	09/18/15	1675	1525	5	-1475	-1475	168253	123433	40	2.4	1.4
08/20/15	to	09/18/15	09/20/15	to	09/25/15	-213	-723	17	-600	-1875	168040	122710	50	1.8	1
08/27/15	to	09/25/15	09/27/15	to	10/02/15	-1113	-1143	1	-1113	-1113	166927	121567	70	3.4	3
09/03/15	to	10/02/15	10/04/15	to	10/09/15	1375	1225	5	-200	-200	168302	122792	70	0.2	2.4
09/10/15	to	10/09/15	10/11/15	to	10/16/15	1088	1028	2	-63	-63	169390	123820	70	2.2	2.6
09/17/15	to	10/16/15	10/18/15	to	10/23/15	2938	2908	1	0	0	172328	126728	70	2.2	2.6
09/24/15	to	10/23/15	10/25/15	to	10/30/15	1213	1093	4	-650	-650	173541	127821	60	2	2.2
10/01/15	to	10/30/15	11/01/15	to	11/06/15	-2750	-3260	17	-2125	-3138	170791	124561	60	0.8	1.2
10/08/15	to	11/06/15	11/08/15	to	11/13/15	-1438	-1588	5	-863	-1638	169353	122973	30	3	0.2
10/15/15	to	11/13/15	11/15/15	to	11/20/15	-1100	-1160	2	-925	-1100	168253	121813	70	2.8	3.4
10/22/15	to	11/20/15	11/22/15	to	11/27/15	125	95	1	0	0	168378	121908	60	3	3.4
10/29/15	to	11/27/15	11/29/15	to	12/04/15	3025	2965	2	0	0	171403	124873	60	3.4	3.4
11/05/15	to	12/04/15	12/06/15	to	12/11/15	-2325	-2415	3	-1613	-2325	169078	122458	60	3	0.8
11/12/15	to	12/11/15	12/13/15	to	12/18/15	-1200	-1620	14	-713	-2250	167878	120838	30	0.6	2.4
11/19/15	to	12/18/15	12/20/15	to	12/25/15	713	683	1	0	0	168591	121521	70	1.6	2.4
11/26/15	to	12/25/15	12/27/15	to	01/01/16	775	745	1	0	0	169366	122266	50	2.6	3.6
12/03/15	to	01/01/16	01/03/16	to	01/08/16	200	-10	7	-788	-1625	169566	122256	60	1.4	2.2
12/10/15	to	01/08/16	01/10/16	to	01/15/16	-1388	-1538	5	-1169	-1981	168178	120718	70	3.2	1.8
12/17/15	to	01/15/16	01/17/16	to	01/22/16	1056	906	5	-731	-969	169234	121624	60	2.8	0.4
12/24/15	to	01/22/16	01/24/16	to	01/29/16	1406	1316	3	0	0	170640	122940	40	0.2	3.4
12/31/15	to	01/29/16	01/31/16	to	02/05/16	5156	4706	15	-263	-281	175796	127646	20	0.2	3
01/07/16	to	02/05/16	02/07/16	to	02/12/16	-1238	-2048	27	-681	-3994	174558	125598	20	1.6	2.6
01/14/16	to	02/12/16	02/14/16	to	02/19/16	925	835	3	-575	-788	175483	126433	20	2.8	0.6
01/21/16	to	02/19/16	02/21/16	to	02/26/16	2263	2113	5	-194	-194	177746	128546	20	2.8	0.8
01/28/16	to	02/26/16	02/28/16	to	03/04/16	-450	-540	3	-594	-594	177296	128006	60	3	2.4
02/04/16	to	03/04/16	03/06/16	to	03/11/16	2050	1990	2	-675	-675	179346	129996	40	3.6	2.8
02/11/16	to	03/11/16	03/13/16	to	03/18/16	1875	1845	1	0	0	181221	131841	50	2.4	2.6
02/18/16	to	03/18/16	03/20/16	to	03/25/16	450	420	1	0	0	181671	132261	50	2.4	2.6
02/25/16	to	03/25/16	03/27/16	to	04/01/16	-594	-684	3	-1150	-1150	181077	131577	50	3.6	2.6
03/03/16	to	04/01/16	04/03/16	to	04/08/16	-500	-770	9	-488	-925	180577	130807	30	2.4	0.8
03/10/16	to	04/08/16	04/10/16	to	04/15/16	1188	798	13	-375	-581	181765	131605	30	2	0.4
03/17/16	to	04/15/16	04/17/16	to	04/22/16	1088	1058	1	0	0	182853	132663	70	3.6	2.4
03/24/16	to	04/22/16	04/24/16	to	04/29/16	1631	1601	1	0	0	184484	134264	30	2.2	3
03/31/16	to	04/29/16	05/01/16	to	05/06/16	1681	1621	2	0	0	186165	135885	70	2	2
04/07/16	to	05/06/16	05/08/16	to	05/13/16	-144	-204	2	-719	-719	186021	135681	60	1.4	1.6
04/14/16	to	05/13/16	05/15/16	to	05/20/16	-1375	-1435	2	-1438	-1438	184646	134246	70	1.6	2.2
04/21/16	to	05/20/16	05/22/16	to	05/27/16	319	229	3	-481	-481	184965	134475	50	1.6	1.6
04/28/16	to	05/27/16	05/29/16	to	06/03/16	681	621	2	-1056	-1056	185646	135096	30	2.4	2
05/05/16	to	06/03/16	06/05/16	to	06/10/16	-1169	-1499	11	-625	-1544	184477	133597	60	0.2	1.4
05/12/16	to	06/10/16	06/12/16	to	06/17/16	-106	-316	7	-475	-850	184371	133281	30	3.2	0.4
05/19/16	to	06/17/16	06/19/16	to	06/24/16	1944	1674	9	-1244	-1244	186315	134955	70	1	3.6
05/26/16	to	06/24/16	06/26/16	to	07/01/16	-1144	-1174	1	-1144	-1144	185171	133781	60	3.4	2.8
06/02/16	to	07/01/16	07/03/16	to	07/08/16	-1506	-1536	1	-1506	-1506	183665	132245	70	2	3.6
06/09/16	to	07/08/16	07/10/16	to	07/15/16	-219	-249	1	-219	-219	183446	131996	70	1	3.6
06/16/16	to	07/15/16	07/17/16	to	07/22/16	-881	-941	2	-838	-881	182565	131055	70	1.8	2.8
06/23/16	to	07/22/16	07/24/16	to	07/29/16	2631	2601	1	0	0	185196	133656	70	0.2	3.4

In-Sample Dates			Out-Of-Sample Dates			osnp	NOnp$30	ont	ollt	odd	EQ	NetEq	N	vup	vdn
06/30/16	to	07/29/16	07/31/16	to	08/05/16	-1056	-1146	3	-988	-1056	184140	132510	20	1.2	2.8
07/07/16	to	08/05/16	08/07/16	to	08/12/16	863	833	1	0	0	185003	133343	20	1.2	3
07/14/16	to	08/12/16	08/14/16	to	08/19/16	1225	1075	5	-325	-569	186228	134418	20	1.2	3
07/21/16	to	08/19/16	08/21/16	to	08/26/16	306	246	2	-706	-706	186534	134664	50	1.6	2.4
07/28/16	to	08/26/16	08/28/16	to	09/02/16	81	21	2	-75	-75	186615	134685	40	2	3.2
08/04/16	to	09/02/16	09/04/16	to	09/09/16	1356	1296	2	0	0	187971	135981	40	2	3
08/11/16	to	09/09/16	09/11/16	to	09/16/16	1044	1014	1	0	0	189015	136995	60	3.6	0.4
08/18/16	to	09/16/16	09/18/16	to	09/23/16	175	145	1	0	0	189190	137140	70	1.8	3.2
08/25/16	to	09/23/16	09/25/16	to	09/30/16	431	401	1	0	0	189621	137541	70	1.8	3.2
09/01/16	to	09/30/16	10/02/16	to	10/07/16	-756	-846	3	-606	-756	188865	136695	40	0.6	2
09/08/16	to	10/07/16	10/09/16	to	10/14/16	-906	-936	1	-906	-906	187959	135759	70	1.6	3.2
09/15/16	to	10/14/16	10/16/16	to	10/21/16	981	951	1	0	0	188940	136710	40	3.2	2.6
09/22/16	to	10/21/16	10/23/16	to	10/28/16	1150	1120	1	0	0	190090	137830	50	2.4	2.6
09/29/16	to	10/28/16	10/30/16	to	11/04/16	550	520	1	0	0	190640	138350	50	2	2
10/06/16	to	11/04/16	11/06/16	to	11/11/16	-2806	-3886	36	-800	-3594	187834	134464	30	1.4	1.2
10/13/16	to	11/11/16	11/13/16	to	11/18/16	2988	2958	1	0	0	190822	137422	60	3	2.2
10/20/16	to	11/18/16	11/20/16	to	11/25/16	1256	1196	2	0	0	192078	138618	20	3.2	1.8
10/27/16	to	11/25/16	11/27/16	to	12/02/16	-2419	-2569	5	-863	-2844	189659	136049	60	2	1.8
11/03/16	to	12/02/16	12/04/16	to	12/09/16	4394	4304	3	-156	-156	194053	140353	40	2.2	2.6
11/10/16	to	12/09/16	12/11/16	to	12/16/16	-150	-600	15	-663	-994	193903	139753	70	1.6	0.8
11/17/16	to	12/16/16	12/18/16	to	12/23/16	-813	-963	5	-775	-1250	193090	138790	40	2.4	1
11/24/16	to	12/23/16	12/25/16	to	12/30/16	525	375	5	-675	-675	193615	139165	40	2.4	1
12/01/16	to	12/30/16	01/01/17	to	01/06/17	1656	1296	12	-500	-781	195271	140461	70	0.4	1.6
12/08/16	to	01/06/17	01/08/17	to	01/13/17	-3113	-3293	6	-1838	-3113	192158	137168	50	2.2	2
12/15/16	to	01/13/17	01/15/17	to	01/20/17	-2025	-2085	2	-1075	-2025	190133	135083	50	2.2	3.4
12/22/16	to	01/20/17	01/22/17	to	01/27/17	-331	-361	1	-331	-331	189802	134722	30	2.6	3
12/29/16	to	01/27/17	01/29/17	to	02/03/17	756	666	3	-931	-994	190558	135388	70	0.4	2.6
01/05/17	to	02/03/17	02/05/17	to	02/10/17	1763	1733	1	0	0	192321	137121	40	2.4	0.2
01/12/17	to	02/10/17	02/12/17	to	02/17/17	156	126	1	0	0	192477	137247	30	2.4	0.2
01/19/17	to	02/17/17	02/19/17	to	02/24/17	1375	1285	3	0	0	193852	138532	30	2.2	1.6
01/26/17	to	02/24/17	02/26/17	to	03/03/17	0	-30	1	0	0	193852	138502	60	1.6	2.6
02/02/17	to	03/03/17	03/05/17	to	03/10/17	469	439	1	0	0	194321	138941	40	2	3.6
02/09/17	to	03/10/17	03/12/17	to	03/17/17	463	403	2	-56	-56	194784	139344	40	3	2.8
02/16/17	to	03/17/17	03/19/17	to	03/24/17							139344	50	2.4	2.4
02/23/17	to	03/24/17	03/26/17	to	03/31/17	1863	1833	1	0	0	196647	141177	40	3.4	1.8
03/02/17	to	03/31/17	04/02/17	to	04/07/17	500	470	1	0	0	197147	141647	60	2.4	1.8
03/09/17	to	04/07/17	04/09/17	to	04/14/17	-494	-524	1	-494	-494	196653	141123	50	2.4	2.4
03/16/17	to	04/14/17	04/16/17	to	04/21/17	219	189	1	0	0	196872	141312	30	2.2	1.8
03/23/17	to	04/21/17	04/23/17	to	04/28/17	-3056	-3296	8	-706	-3125	193816	138016	30	2.2	1.8

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.