

# Trading the 24hr Euro Fx Futures With The Least Squares Velocity Strategy

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In previous working papers [Ref below] 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.

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

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

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

## The 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:

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

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

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

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

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

Here we will use the **velocity** of the least squares straight line to create a strategy. The least squares velocity has the advantage that it is a natural random 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 and on the trading floor at the CME. On Globex the EC is traded on a 23hour basis. The CME hours for floor trading (RTH) are 7:20 to 14:00 CST. Over 50% of the volume in the EC is done on Globex is during the CME RTH hours. However for this paper we will trade all hours that Globex is open. To test this strategy we will use 1 minute bar prices of the EC futures contract for the four years from September 2, 2010 to October 3, 2014

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

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

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

Why use the walk forward technique? Why not just perform an optimization on the whole price series and choose the input parameters that give the best total net profits or profit factor? Surely the price noise cancels itself out with such a large number of in-sample prices and trades. Unfortunately, nothing could be farther from the truth! Optimization is a misnomer and should

really be called combinatorial search. As stated above, whenever we run a combinatorial search over many different combinations of input parameters on noisy data on a fixed number of prices, **no matter how many**, the best performance parameters found are guaranteed to be due to “**curve fitting**” the noise and signal. The price series that we trade consists of random spurious price movements, which we call noise, and repeatable price patterns (*if they exist*). When we run, for example, 5000 different inputs parameter combinations, the best performance parameters will be from those strategy input variables that are able to produce profits from the price pattern **and** the random spurious movements. While the price patterns will repeat, the same spurious price movements will not. If the spurious price movements that were captured by a certain set of input parameters were a large part of the total net profits, as they are in real intraday price series, then choosing these input parameters will produce losses when traded on future data. These losses occur because the spurious price movements will not be repeated in the same way. This is why strategy optimization or combinatorial searches with no out-of-sample testing cause losses when traded in real time from something that looked great in the in-sample section.

In order to gain confidence that our input parameter selection method using the optimization output of the in-sample data will produce profits, we must test the input parameters we found in the in-sample section on out-of-sample data. In addition, we must perform the in-sample/out-of-sample analysis many times. Why not just do the out-of-sample analysis once or just 10 times? Well just as in Poker or any card game, where there is considerable variation in luck from hand to hand, walk forward out-of-sample analysis give considerable variation in week-to-week out-of-sample profit “luck”. That is, by pure chance we may have chosen some input parameter set that did well in the in-sample section data **and** the out-of-sample section data. In order to minimize this type of “luck”, statistically, we must repeat the walk forward out-of-sample (oos) analysis over many (>30) in-sample/out-of-sample sections and take an average over all out-of-sample sections. This average gives us an expected out-of-sample return and a standard deviation of out-of-sample returns which allows us to statistically estimate the expected equity and its range for N out-of-sample periods in the future

### **Finding The Strategy Parameters Using Walk Forward Optimization**

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

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

1.  $N$  from 20 to 70 in steps of 10
2.  $vup$  from 0.2 to 3 steps of 0.2
3.  $vdn$  from 0.2 to 3 in steps of 0.2
4.  $Mult=4303*\sqrt{N}$  Note: this normalizes the Velocity range for each  $N$  to one standard deviation. Else the Velocity would have different ranges for different  $N$  and it would be difficult to find a  $vup$  and  $vdn$  that worked for all  $N$  ranges. See Appendix for a detailed explanation.

This will produce 1350 different input combinations or cases of the strategy input parameters for each of the 209 in-sample/out-of-sample files for the two years of 1min bar EC data.

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

When TS does an optimization over many combinations of inputs, it creates output page that has as its rows each strategy input combination and as its 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. From experience, it is known that most curve fitted strategy results have high Profit Factors (PF). So for our filter we will eliminate all rows in the in-sample section that have a  $PF > 2.8$ . After using the **PF** filter, as described, there can still be 100's of rows left in the in-sample section. Not many traders can stay with a strategy that has a large number of losing trades in a row (**LR**). For this filter we will choose  $LR \leq 5$ . In addition we would like there to be at least a series of 5 winning trades in a row  $WR \geq 5$ . So we will eliminate the rows in the in-sample section that have  $WR < 5$  and  $LR > 5$ . This choice of LR and WR was found by filter program. There is a performance metric called **percentage profitable (%P)**. This is the percentage of trades that are profitable in the in-sample section. We choose the row that is left after the **PF-WR-LR** row elimination that has the highest **%P** metric. We abbreviate this final filter as **pf<28|w5|l5|-%P**. For each in-sample section this filter leaves only one row in the in-sample section with its associated strategy inputs and out-of-sample net profit in the out-of-sample section using the strategy inputs found in the in-sample section. This particular **pf<28|w5|l5|-%P filter** is then applied to each of the 209 in-sample sections which give 209 sets of strategy inputs that are used to produce the corresponding 209 out-of-sample performance results. The average out-of-sample performance is calculated from these 209 out-of-sample performance results. In addition many other important out-of-sample performance statistics for this filter are calculated and summarized. **Figure 3** shows such a computer run along with a small sample of other filter combinations that are constructed in a similar manner. Row 3 of the sample output in Figure 3 shows the results of the filter discussed above.

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

Using modern "Bootstrap" techniques, we can calculate the probability of obtaining our filter's total out-of-sample *net* profits by chance. Here is how the bootstrap technique is applied. Suppose as an example, we have 100 files of in-sample/out-of-sample data. A mirror random filter is created. Instead of picking an out-of-sample net profit (OSNP) from a filter row as before, the mirror filter picks a *random* row's OSNP in each of the 100 files. We repeat this random picking in each of the 100 files 5000 times. Each of the 5000 mirror filters will choose a random row's OSNP of their own in each of the 100 files.. At the end, each of the 5000 mirror

filters will have 100 *random* OSNP's picked from the rows of the 100 files. The sum of the 100 random OSNP picks for each mirror filter will generate a random total out-of-sample net profit (tOnpNet) or final random equity. The average and standard deviation of the 5000 mirror filter's different random tOnpNets will allow us to calculate the chance probability of our above chosen filter's tOnpNet. Thus given the mirror filter's bootstrap random tOnpNet average and standard deviation, we can calculate the probability of obtaining our chosen filter's tOnpNet by pure chance alone. Figure 3 lists the 5000 mirror filter's bootstrap average for our 209 out-of-sample files of **(\$90330)** with a bootstrap standard deviation of **\$29,321**. The probability for obtaining our filters net profit of **\$86,620** is  $7.95 \cdot 10^{-10}$  which is **6.03** standard deviations from the bootstrap average. For our filter, in row 3 in Figure 3, the expected number of cases that we could obtain by pure chance that would match or exceed the **\$86,620** is  $4464 \times 7.95 \cdot 10^{-10} = 0.00000355$  where **4464** is the total number of different filters we looked at in this run. This number is much less than 1, so it is improbable that our result was due to pure chance.

## Results

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

**Figure 1** presents a graph of the equity curve generated by using the filter on the 209 weeks ending 10/8/2010 – 10/3/2014 (note the first month starting 9/2/2010 was part of the first 30 day in-sample period). The equity curves is plotted from Equity and Net Equity columns in Table 1. Plotted on the equity curves is the 2<sup>nd</sup> Order Polynomial curve. The blue line is the equity curve without commissions and the red dots on the blue line are new highs in equity. The brown line is the net equity curve with commissions and the green dots are the new highs in net equity.

**Figure 2** presents the out-of-sample 1 minute bar chart of EC for 9/2/14 to 9/5/14 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 13 weeks for this filter. This means that 13 weeks was the longest time that the equity for this strategy failed to make a new equity high.

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

In Figure 1, which presents a graph of the equity curve using the filter on the 209 weeks of out-of-sample data, notice how the equity curve follows the 2<sup>nd</sup> order polynomial trend line with an  $R^2$  of 0.97. This  $R^2$  dropped to 0.96 for the net equity curve.

Using this filter, the strategy was able to generate \$86,620 net equity after commissions and slippage of \$30 trading one EC contract for 209 weeks. This period of time from 10/8/10 to 10/3/14 was a volatile market. Yet the LSQV strategy was able to adapt quite well. From Table 1, the largest losing week was -\$6688 on the week ending 8/5/11 a very wild financial time and market week. The largest drawdown was -\$8638 from the week ending on 7/8/11 to 8/5/11.. However this drawdown only lasted four weeks and completely recovered and made a new equity high in another five weeks. The longest time between new equity highs was 13 weeks.

In observing Table 1 we can see that this strategy and filter made trades from a low of 1 trade/week to a high of 48 trades/week with an average of 6.0 trades/week.

### **Disclaimer**

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

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

EC-1 min bars 9/1/2010 - 10/3/2014 using the below filter on each in-sample segment. The input values *N*, *vup*, and *vdn* are the values found from applying the filter to the in-sample section.

**In-sample Section Filter:**  $pf < 28|w5|I5| - \%P$

Where:

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

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

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

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

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

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

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

Week	In-Sample Dates			Out-Of-Sample Dates			Osnp	Equity	NOnp\$30	NetEq	ollt	odd	Ont	N	vup	vdn
		To		To	To											
1	09/01/10	To	10/01/10	10/04/10	To	10/08/10	1300	1300	820	820	-775	-1563	16	30	0.6	2.2
2	09/08/10	To	10/08/10	10/11/10	To	10/15/10	(350)	950	(770)	50	-1225	-2088	14	20	3	2.2
3	09/15/10	To	10/15/10	10/18/10	To	10/22/10	(2138)	(1188)	(2528)	(2478)	-1163	-4050	13	20	3	2.6
4	09/22/10	To	10/22/10	10/25/10	To	10/29/10	1125	(63)	1095	(1383)	0	0	1	70	2.6	1.4
5	09/29/10	To	10/29/10	11/01/10	To	11/05/10	1975	1912	1825	442	-1163	-2013	5	70	2.6	1.4
6	10/06/10	To	11/05/10	11/08/10	To	11/12/10	5100	7012	4980	5422	0	0	4	70	2.6	1.4
7	10/13/10	To	11/12/10	11/15/10	To	11/19/10	(1275)	5737	(1335)	4087	-750	-750	2	70	3	1.4
8	10/20/10	To	11/19/10	11/22/10	To	11/26/10	5413	11150	5293	9380	-813	-950	4	70	2.8	1.8
9	10/27/10	To	11/26/10	11/29/10	To	12/03/10	3450	14600	3360	12740	-700	-1163	3	60	2.6	2.2
10	11/03/10	To	12/03/10	12/06/10	To	12/10/10	(163)	14437	(193)	12547	0	0	1	60	2.8	2.6
11	11/10/10	To	12/10/10	12/13/10	To	12/17/10	888	15325	828	13375	-650	-650	2	60	2.8	2.6
12	11/17/10	To	12/17/10	12/20/10	To	12/24/10	(900)	14425	(1050)	12325	-950	-1400	5	20	3	3
13	11/24/10	To	12/24/10	12/27/10	To	12/31/10	3300	17725	3180	15505	-563	-663	4	30	0.4	3
14	12/01/10	To	12/31/10	01/03/11	To	01/07/11	4663	22388	4603	20108	-550	-1050	2	60	2.8	1.4
15	12/08/10	To	01/07/11	01/10/11	To	01/14/11	2175	24563	1875	21983	-750	-1225	10	70	1.4	1.6
16	12/15/10	To	01/14/11	01/17/11	To	01/21/11	750	25313	570	22553	-800	-1588	6	60	1.2	2.4
17	12/22/10	To	01/21/11	01/24/11	To	01/28/11	(2188)	23125	(2368)	20185	-2238	-5350	6	70	2.2	2
18	12/29/10	To	01/28/11	01/31/11	To	02/04/11	1525	24650	1465	21650	-500	-500	2	60	2	2.4
19	01/05/11	To	02/04/11	02/07/11	To	02/11/11	438	25088	408	22058	0	0	1	30	2.6	2.4
20	01/12/11	To	02/11/11	02/14/11	To	02/18/11	(1150)	23938	(1240)	20818	-1325	-2475	3	30	2.6	2.4
21	01/19/11	To	02/18/11	02/21/11	To	02/25/11	713	24651	683	21501	0	0	1	30	0.4	3
22	01/26/11	To	02/25/11	02/28/11	To	03/04/11	(238)	24413	(328)	21173	-788	-1838	3	60	2	1.8
23	02/02/11	To	03/04/11	03/07/11	To	03/11/11	3725	28138	3515	24688	-125	-125	7	70	1.4	0.2
24	02/09/11	To	03/11/11	03/14/11	To	03/18/11	2375	30513	1685	26373	-613	-1325	23	70	1.4	0.2
25	02/16/11	To	03/18/11	03/21/11	To	03/25/11	1500	32013	1440	27813	-500	-500	2	60	2.2	0.4
26	02/23/11	To	03/25/11	03/28/11	To	04/01/11	(600)	31413	(840)	26973	-1300	-1988	8	60	2.2	0.4
27	03/02/11	To	04/01/11	04/04/11	To	04/08/11	(500)	30913	(620)	26353	-1000	-1863	4	20	3	2.2
Week	In-Sample Dates			Out-Of-Sample Dates			Osnp	Equity	NOnp\$30	NetEq	ollt	odd	Ont	N	vup	vdn



Week	In-Sample Dates			Out-Of-Sample Dates			Osnp	Equity	NOnp\$30	NetEq	ollt	odd	Ont	N	vup	vdn
28	03/09/11	To	04/08/11	04/11/11	To	04/15/11	650	31563	500	26853	-363	-550	5	50	2.4	1.4
29	03/16/11	To	04/15/11	04/18/11	To	04/22/11	(75)	31488	(285)	26568	-1100	-2000	7	30	2.6	2.2
30	03/23/11	To	04/22/11	04/25/11	To	04/29/11	1050	32538	810	27378	-700	-700	8	50	2.4	1.6
31	03/30/11	To	04/29/11	05/02/11	To	05/06/11	(963)	31575	(1473)	25905	-1125	-5500	17	40	1.8	2
32	04/06/11	To	05/06/11	05/09/11	To	05/13/11	1163	32738	563	26468	-900	-2463	20	60	2	1.2
33	04/13/11	To	05/13/11	05/16/11	To	05/20/11	(375)	32363	(1095)	25373	-863	-2463	24	20	1.8	2
34	04/20/11	To	05/20/11	05/23/11	To	05/27/11	1538	33901	908	26281	-700	-2775	21	20	1.8	2
35	04/27/11	To	05/27/11	05/30/11	To	06/03/11	4250	38151	4220	30501	0	0	1	40	2	3
36	05/04/11	To	06/03/11	06/06/11	To	06/10/11	650	38801	560	31061	-1200	-1250	3	40	2	3
37	05/11/11	To	06/10/11	06/13/11	To	06/17/11	2613	41414	2193	33254	-425	-1075	14	70	1.4	1.4
38	05/18/11	To	06/17/11	06/20/11	To	06/24/11	3400	44814	2860	36114	-663	-1563	18	40	1.4	1.8
39	05/25/11	To	06/24/11	06/27/11	To	07/01/11	4213	49027	4183	40297	0	0	1	50	1.6	3
40	06/01/11	To	07/01/11	07/04/11	To	07/08/11	750	49777	450	40747	-863	-1300	10	60	1.6	2
41	06/08/11	To	07/08/11	07/11/11	To	07/15/11	(2863)	46914	(3433)	37314	-1475	-4763	19	20	3	3
42	06/15/11	To	07/15/11	07/18/11	To	07/22/11	900	47814	840	38154	-888	-888	2	70	1.8	3
43	06/22/11	To	07/22/11	07/25/11	To	07/29/11	13	47827	(107)	38047	-1063	-1363	4	70	1.6	3
44	06/29/11	To	07/29/11	08/01/11	To	08/05/11	(6688)	41139	(8128)	29919	-713	-7163	48	50	1.2	1.4
45	07/06/11	To	08/05/11	08/08/11	To	08/12/11	1425	42564	1245	31164	-888	-1013	6	60	3	2.8
46	07/13/11	To	08/12/11	08/15/11	To	08/19/11	313	42877	253	31417	-738	-738	2	60	3	2.8
47	07/20/11	To	08/19/11	08/22/11	To	08/26/11	638	43515	578	31995	-325	-375	2	60	3	2.8
48	07/27/11	To	08/26/11	08/29/11	To	09/02/11	3725	47240	3695	35690	0	0	1	50	3	0.4
49	08/03/11	To	09/02/11	09/05/11	To	09/09/11	3700	50940	3610	39300	-825	-825	3	50	3	3
50	08/10/11	To	09/09/11	09/12/11	To	09/16/11	(3050)	47890	(3470)	35830	-1325	-4713	14	70	2.4	0.6
51	08/17/11	To	09/16/11	09/19/11	To	09/23/11	1500	49390	960	36790	-775	-3138	18	60	2.4	0.6
52	08/24/11	To	09/23/11	09/26/11	To	09/30/11	3663	53053	3333	40123	-850	-1500	11	40	2.4	2.4
53	08/31/11	To	09/30/11	10/03/11	To	10/07/11	3550	56603	3400	43523	-88	-88	5	40	2.2	3
54	09/07/11	To	10/07/11	10/10/11	To	10/14/11	88	56691	(2)	43521	-1338	-1338	3	60	2.8	3
55	09/14/11	To	10/14/11	10/17/11	To	10/21/11	5538	62229	5358	48879	-175	-175	6	30	2.8	3
56	09/21/11	To	10/21/11	10/24/11	To	10/28/11	3138	65367	3078	51957	0	0	2	70	1.6	3
57	09/28/11	To	10/28/11	10/31/11	To	11/04/11	(1400)	63967	(1820)	50137	-2238	-2600	14	50	1.6	3
58	10/05/11	To	11/04/11	11/07/11	To	11/11/11	1050	65017	870	51007	-1263	-3025	6	30	2.6	2.8
59	10/12/11	To	11/11/11	11/14/11	To	11/18/11	313	65330	43	51050	-763	-2088	9	30	2.6	2.8
60	10/19/11	To	11/18/11	11/21/11	To	11/25/11	338	65668	308	51358	0	0	1	40	2	3
61	10/26/11	To	11/25/11	11/28/11	To	12/02/11	1400	67068	1280	52638	0	0	4	40	2	3
62	11/02/11	To	12/02/11	12/05/11	To	12/09/11	(775)	66293	(955)	51683	-863	-1300	6	60	0.2	3
63	11/09/11	To	12/09/11	12/12/11	To	12/16/11	3600	69893	3480	55163	-163	-163	4	40	2.6	0.6
64	11/16/11	To	12/16/11	12/19/11	To	12/23/11	238	70131	(2)	55161	-500	-500	8	20	1.6	3
65	11/23/11	To	12/23/11	12/26/11	To	12/30/11	(550)	69581	(610)	54551	-875	-1100	2	70	1.8	2.6
66	11/30/11	To	12/30/11	01/02/12	To	01/06/12	(1200)	68381	(1380)	53171	-975	-1238	6	20	1.6	3
67	12/07/11	To	01/06/12	01/09/12	To	01/13/12	2075	70456	1835	55006	-713	-713	8	20	0.6	2.8
68	12/14/11	To	01/13/12	01/16/12	To	01/20/12	763	71219	463	55469	-388	-875	10	20	1.6	2.8
69	12/21/11	To	01/20/12	01/23/12	To	01/27/12	(1213)	70006	(1423)	54046	-1713	-3563	7	70	2.6	1.4
70	12/28/11	To	01/27/12	01/30/12	To	02/03/12	(850)	69156	(940)	53106	-388	-388	3	70	2.6	1.6
71	01/04/12	To	02/03/12	02/06/12	To	02/10/12	2450	71606	2390	55496	0	0	2	70	2.6	1.6
72	01/11/12	To	02/10/12	02/13/12	To	02/17/12	(675)	70931	(795)	54701	-1088	-1300	4	70	2.6	1.6

Week	In-Sample Dates			Out-Of-Sample Dates			Osnp	Equity	NOnp\$30	NetEq	ollt	odd	Ont	N	vup	vdn
73	01/18/12	To	02/17/12	02/20/12	To	02/24/12	2000	72931	1880	56581	-438	-900	4	60	1	2.4
74	01/25/12	To	02/24/12	02/27/12	To	03/02/12	(3063)	69868	(3183)	53398	-525	-775	4	30	0.6	3
75	02/01/12	To	03/02/12	03/05/12	To	03/09/12	(163)	69705	(223)	53175	-2738	-2738	2	60	0.2	2.8
76	02/08/12	To	03/09/12	03/12/12	To	03/16/12	(575)	69130	(665)	52510	-700	-1275	3	40	2.2	1
77	02/15/12	To	03/16/12	03/19/12	To	03/23/12	113	69243	(127)	52383	-688	-688	8	40	2.2	1
78	02/22/12	To	03/23/12	03/26/12	To	03/30/12	700	69943	640	53023	-88	-88	2	40	0.4	2.8
79	02/29/12	To	03/30/12	04/02/12	To	04/06/12	1463	71406	1403	54426	0	0	2	20	2.4	3
80	03/07/12	To	04/06/12	04/09/12	To	04/13/12	(50)	71356	(80)	54346	0	0	1	40	0.4	2.8
81	03/14/12	To	04/13/12	04/16/12	To	04/20/12	1388	72744	1328	55674	-1950	-2125	2	40	0.2	2.8
82	03/21/12	To	04/20/12	04/23/12	To	04/27/12	400	73144	280	55954	-88	-150	4	20	0.2	2.6
83	03/28/12	To	04/27/12	04/30/12	To	05/04/12	1238	74382	1088	57042	-238	-538	5	30	1.4	1.4
84	04/04/12	To	05/04/12	05/07/12	To	05/11/12	(2075)	72307	(2315)	54727	-1775	-2763	8	20	1.2	2.6
85	04/11/12	To	05/11/12	05/14/12	To	05/18/12	0	72307	(120)	54607	-488	-488	4	20	1.2	2.8
86	04/18/12	To	05/18/12	05/21/12	To	05/25/12	(2825)	69482	(3065)	51542	-825	-1550	8	20	1.6	2.8
87	04/25/12	To	05/25/12	05/28/12	To	06/01/12	1013	70495	653	52195	-675	-1175	12	50	1.4	0.8
88	05/02/12	To	06/01/12	06/04/12	To	06/08/12	688	71183	178	52373	-650	-1725	17	50	1.4	0.8
89	05/09/12	To	06/08/12	06/11/12	To	06/15/12	900	72083	630	53003	-438	-1313	9	70	1.2	1.4
90	05/16/12	To	06/15/12	06/18/12	To	06/22/12	(1450)	70633	(1630)	51373	-1175	-2413	6	40	3	1.4
91	05/23/12	To	06/22/12	06/25/12	To	06/29/12	1400	72033	1340	52713	-2938	-2938	2	30	2.2	3
92	05/30/12	To	06/29/12	07/02/12	To	07/06/12	1075	73108	1045	53758	0	0	1	30	2.2	3
93	06/06/12	To	07/06/12	07/09/12	To	07/13/12	450	73558	360	54118	-638	-638	3	20	1.6	3
94	06/13/12	To	07/13/12	07/16/12	To	07/20/12	338	73896	98	54216	-1050	-1875	8	30	2.6	0.8
95	06/20/12	To	07/20/12	07/23/12	To	07/27/12	2600	76496	2360	56576	-725	-1338	8	20	0.6	3
96	06/27/12	To	07/27/12	07/30/12	To	08/03/12	300	76796	90	56666	-1163	-1925	7	30	1.8	2.2
97	07/04/12	To	08/03/12	08/06/12	To	08/10/12	(1150)	75646	(1180)	55486	0	0	1	20	0.4	3
98	07/11/12	To	08/10/12	08/13/12	To	08/17/12	(288)	75358	(348)	55138	-375	-375	2	40	1.8	2.4
99	07/18/12	To	08/17/12	08/20/12	To	08/24/12	(663)	74695	(783)	54355	-888	-1250	4	40	2.6	1.4
100	07/25/12	To	08/24/12	08/27/12	To	08/31/12	(850)	73845	(880)	53475	0	0	1	40	2.6	1.4
101	08/01/12	To	08/31/12	09/03/12	To	09/07/12	1825	75670	1795	55270	0	0	1	40	2.6	1.8
102	08/08/12	To	09/07/12	09/10/12	To	09/14/12	3900	79570	3870	59140	0	0	1	40	2.4	1.8
103	08/15/12	To	09/14/12	09/17/12	To	09/21/12	(3938)	75632	(4688)	54452	-713	-3675	25	70	0.6	1
104	08/22/12	To	09/21/12	09/24/12	To	09/28/12	1688	77320	1448	55900	-400	-450	8	40	1.6	1
105	08/29/12	To	09/28/12	10/01/12	To	10/05/12	(113)	77207	(353)	55547	-800	-938	8	70	1.4	0.6
106	09/05/12	To	10/05/12	10/08/12	To	10/12/12	1013	78220	953	56500	-750	-788	2	30	2.8	0.8
107	09/12/12	To	10/12/12	10/15/12	To	10/19/12	(363)	77857	(483)	56017	-900	-1300	4	20	3	1
108	09/19/12	To	10/19/12	10/22/12	To	10/26/12	963	78820	933	56950	0	0	1	20	2.8	1
109	09/26/12	To	10/26/12	10/29/12	To	11/02/12	713	79533	653	57603	-325	-563	2	60	1.8	2
110	10/03/12	To	11/02/12	11/05/12	To	11/09/12	725	80258	665	58268	-475	-475	2	30	2.2	1.4
111	10/10/12	To	11/09/12	11/12/12	To	11/16/12	(300)	79958	(330)	57938	0	0	1	20	1.6	2
112	10/17/12	To	11/16/12	11/19/12	To	11/23/12	(1975)	77983	(2125)	55813	-1263	-2950	5	60	1.6	1
113	10/24/12	To	11/23/12	11/26/12	To	11/30/12	(363)	77620	(423)	55390	-2038	-2175	2	70	1.8	0.2
114	10/31/12	To	11/30/12	12/03/12	To	12/07/12	1625	79245	1505	56895	-450	-475	4	20	1	2
115	11/07/12	To	12/07/12	12/10/12	To	12/14/12	3038	82283	2918	59813	-38	-38	4	30	0.2	2
116	11/14/12	To	12/14/12	12/17/12	To	12/21/12	1375	83658	955	60768	-538	-850	14	20	0.8	1.4
117	11/21/12	To	12/21/12	12/24/12	To	12/28/12	(388)	83270	(688)	60080	-475	-1225	10	40	1	1

Week	In-Sample Dates			Out-Of-Sample Dates			Osnp	Equity	NOnp\$30	NetEq	ollt	odd	Ont	N	vup	vdn
118	11/28/12	To	12/28/12	12/31/12	To	01/04/13	925	84195	625	60705	-413	-988	10	20	1.4	1.8
119	12/05/12	To	01/04/13	01/07/13	To	01/11/13	2613	86808	2433	63138	-263	-263	6	50	0.4	1.6
120	12/12/12	To	01/11/13	01/14/13	To	01/18/13	325	87133	295	63433	0	0	1	30	3	1.6
121	12/19/12	To	01/18/13	01/21/13	To	01/25/13	(425)	86708	(665)	62768	-425	-975	8	20	2.4	1.8
122	12/26/12	To	01/25/13	01/28/13	To	02/01/13	(913)	85795	(1033)	61735	-2713	-2713	4	30	3	1
123	01/02/13	To	02/01/13	02/04/13	To	02/08/13	2113	87908	1933	63668	-663	-1213	6	30	3	1
124	01/09/13	To	02/08/13	02/11/13	To	02/15/13	(1250)	86658	(1370)	62298	-625	-1288	4	50	2.2	0.8
125	01/16/13	To	02/15/13	02/18/13	To	02/22/13	(1125)	85533	(1305)	60993	-525	-838	6	20	0.8	3
126	01/23/13	To	02/22/13	02/25/13	To	03/01/13	(1113)	84420	(1383)	59610	-838	-1200	9	30	1.4	2.6
127	01/30/13	To	03/01/13	03/04/13	To	03/08/13	550	84970	490	60100	-675	-675	2	30	1.4	2.6
128	02/06/13	To	03/08/13	03/11/13	To	03/15/13	1288	86258	1228	61328	-113	-113	2	30	1.4	2.6
129	02/13/13	To	03/15/13	03/18/13	To	03/22/13	450	86708	300	61628	-700	-1338	5	70	2	1
130	02/20/13	To	03/22/13	03/25/13	To	03/29/13	1363	88071	1243	62871	-675	-775	4	50	2	0.6
131	02/27/13	To	03/29/13	04/01/13	To	04/05/13	1363	89434	1243	64114	-488	-1013	4	30	1.4	2
132	03/06/13	To	04/05/13	04/08/13	To	04/12/13	1400	90834	1370	65484	0	0	1	40	1.2	2
133	03/13/13	To	04/12/13	04/15/13	To	04/19/13	(2400)	88434	(2700)	62784	-563	-1300	10	30	1.6	2
134	03/20/13	To	04/19/13	04/22/13	To	04/26/13	175	88609	85	62869	-1275	-1275	3	40	2.4	2.2
135	03/27/13	To	04/26/13	04/29/13	To	05/03/13	3400	92009	2800	65669	-563	-850	20	20	0.2	1.6
136	04/03/13	To	05/03/13	05/06/13	To	05/10/13	288	92297	198	65867	-425	-725	3	40	2	2.4
137	04/10/13	To	05/10/13	05/13/13	To	05/17/13	638	92935	518	66385	-963	-1500	4	30	1.6	2.6
138	04/17/13	To	05/17/13	05/20/13	To	05/24/13	1813	94748	1753	68138	0	0	2	40	0.2	2.6
139	04/24/13	To	05/24/13	05/27/13	To	05/31/13	538	95286	418	68556	-188	-188	4	40	0.2	2.6
140	05/01/13	To	05/31/13	06/03/13	To	06/07/13	2700	97986	2640	71196	-38	-38	2	40	0.2	2.6
141	05/08/13	To	06/07/13	06/10/13	To	06/14/13	1650	99636	1620	72816	0	0	1	40	0.6	2.6
142	05/15/13	To	06/14/13	06/17/13	To	06/21/13	(1013)	98623	(1133)	71683	-1500	-1500	4	40	0.6	2.6
143	05/22/13	To	06/21/13	06/24/13	To	06/28/13	(613)	98010	(763)	70920	-825	-1325	5	50	1.4	2.2
144	05/29/13	To	06/28/13	07/01/13	To	07/05/13	(1263)	96747	(1323)	69597	-1725	-1988	2	50	1.4	2.2
145	06/05/13	To	07/05/13	07/08/13	To	07/12/13	5713	102460	5113	74710	-450	-1200	20	40	0.2	1.4
146	06/12/13	To	07/12/13	07/15/13	To	07/19/13	663	103123	603	75313	-138	-138	2	30	0.6	3
147	06/19/13	To	07/19/13	07/22/13	To	07/26/13	1125	104248	1005	76318	-638	-950	4	30	1	1.6
148	06/26/13	To	07/26/13	07/29/13	To	08/02/13	(225)	104023	(345)	75973	-63	-138	4	40	0.4	2.4
149	07/03/13	To	08/02/13	08/05/13	To	08/09/13	775	104798	745	76718	0	0	1	30	0.4	2.6
150	07/10/13	To	08/09/13	08/12/13	To	08/16/13	(50)	104748	(230)	76488	-563	-1225	6	20	1.2	1.8
151	07/17/13	To	08/16/13	08/19/13	To	08/23/13	0	104748	(180)	76308	-500	-1113	6	30	0.2	1.6
152	07/24/13	To	08/23/13	08/26/13	To	08/30/13	(1663)	103085	(1903)	74405	-488	-1050	8	20	0.4	2.4
153	07/31/13	To	08/30/13	09/02/13	To	09/06/13	13	103098	(47)	74358	-1750	-1750	2	20	0.6	2.8
154	08/07/13	To	09/06/13	09/09/13	To	09/13/13	1513	104611	1483	75841	0	0	1	20	0.4	2.8
155	08/14/13	To	09/13/13	09/16/13	To	09/20/13	2250	106861	2070	77911	-225	-463	6	30	0.4	1.6
156	08/21/13	To	09/20/13	09/23/13	To	09/27/13	(713)	106148	(1163)	76748	-375	-1463	15	30	0.4	1.2
157	08/28/13	To	09/27/13	09/30/13	To	10/04/13	2025	108173	1725	78473	-300	-300	10	60	0.6	0.8
158	09/04/13	To	10/04/13	10/07/13	To	10/11/13	(1100)	107073	(1610)	76863	-300	-1013	17	60	0.6	0.8
159	09/11/13	To	10/11/13	10/14/13	To	10/18/13	1813	108886	1603	78466	-338	-488	7	20	1.2	1.8
160	09/18/13	To	10/18/13	10/21/13	To	10/25/13	(2150)	106736	(2330)	76136	-1225	-2563	6	40	1.6	1
161	09/25/13	To	10/25/13	10/28/13	To	11/01/13	1638	108374	1338	77474	-438	-1225	10	60	0.8	1
162	10/02/13	To	11/01/13	11/04/13	To	11/08/13	(100)	108274	(340)	77134	-1000	-2200	8	40	0.2	1.8

Week	In-Sample Dates			Out-Of-Sample Dates			Osnp	Equity	NOnp\$30	NetEq	ollt	odd	Ont	N	vup	vdn
163	10/09/13	To	11/08/13	11/11/13	To	11/15/13	1200	109474	1140	78274	-188	-188	2	40	1	1.8
164	10/16/13	To	11/15/13	11/18/13	To	11/22/13	1500	110974	1440	79714	0	0	2	50	0.2	3
165	10/23/13	To	11/22/13	11/25/13	To	11/29/13	388	111362	358	80072	0	0	1	50	0.2	3
166	10/30/13	To	11/29/13	12/02/13	To	12/06/13	1513	112875	1483	81555	0	0	1	50	0.2	3
167	11/06/13	To	12/06/13	12/09/13	To	12/13/13	413	113288	383	81938	0	0	1	50	0.2	3
168	11/13/13	To	12/13/13	12/16/13	To	12/20/13	463	113751	403	82341	0	0	2	40	0.6	2
169	11/20/13	To	12/20/13	12/23/13	To	12/27/13	900	114651	870	83211	0	0	1	50	0.4	1.8
170	11/27/13	To	12/27/13	12/30/13	To	01/03/14	725	115376	665	83876	-625	-625	2	40	1.2	1.6
171	12/04/13	To	01/03/14	01/06/14	To	01/10/14	563	115939	443	84319	-588	-950	4	50	0.2	1.8
172	12/11/13	To	01/10/14	01/13/14	To	01/17/14	(1725)	114214	(1785)	82534	-13	-13	2	40	0.2	2
173	12/18/13	To	01/17/14	01/20/14	To	01/24/14	(425)	113789	(725)	81809	-538	-875	10	50	1.4	0.4
174	12/25/13	To	01/24/14	01/27/14	To	01/31/14	2438	116227	2318	84127	-163	-163	4	60	1.6	0.4
175	01/01/14	To	01/31/14	02/03/14	To	02/07/14	(575)	115652	(605)	83522	0	0	1	60	2.8	1.6
176	01/08/14	To	02/07/14	02/10/14	To	02/14/14	(413)	115239	(443)	83079	0	0	1	70	2.6	1.2
177	01/15/14	To	02/14/14	02/17/14	To	02/21/14	(575)	114664	(635)	82444	-975	-1000	2	30	2.2	0.4
178	01/22/14	To	02/21/14	02/24/14	To	02/28/14	188	114852	98	82542	-275	-663	3	20	0.8	2.2
179	01/29/14	To	02/28/14	03/03/14	To	03/07/14	925	115777	745	83287	-500	-525	6	20	0.2	2.2
180	02/05/14	To	03/07/14	03/10/14	To	03/14/14	413	116190	293	83580	-475	-538	4	20	0.4	2.4
181	02/12/14	To	03/14/14	03/17/14	To	03/21/14	(300)	115890	(540)	83040	-463	-1338	8	20	1.4	1.4
182	02/19/14	To	03/21/14	03/24/14	To	03/28/14	(1225)	114665	(1405)	81635	-888	-1350	6	70	0.8	1.6
183	02/26/14	To	03/28/14	03/31/14	To	04/04/14	613	115278	583	82218	0	0	1	40	2.2	0.2
184	03/05/14	To	04/04/14	04/07/14	To	04/11/14	(1875)	113403	(1935)	80283	-125	-125	2	40	2.2	0.2
185	03/12/14	To	04/11/14	04/14/14	To	04/18/14	900	114303	870	81153	0	0	1	20	3	1
186	03/19/14	To	04/18/14	04/21/14	To	04/25/14	(250)	114053	(280)	80873	0	0	1	20	3	1.2
187	03/26/14	To	04/25/14	04/28/14	To	05/02/14	888	114941	768	81641	-250	-250	4	20	0.4	2.8
188	04/02/14	To	05/02/14	05/05/14	To	05/09/14	2488	117429	2458	84099	0	0	1	20	2.2	3
189	04/09/14	To	05/09/14	05/12/14	To	05/16/14	(100)	117329	(220)	83879	-2125	-2250	4	20	0.4	2.4
190	04/16/14	To	05/16/14	05/19/14	To	05/23/14	(800)	116529	(830)	83049	0	0	1	30	0.4	2.8
191	04/23/14	To	05/23/14	05/26/14	To	05/30/14	50	116579	20	83069	0	0	1	30	0.4	2.8
192	04/30/14	To	05/30/14	06/02/14	To	06/06/14	2263	118842	1963	85032	-325	-550	10	50	0.8	0.2
193	05/07/14	To	06/06/14	06/09/14	To	06/13/14	(88)	118754	(508)	84524	-325	-950	14	70	0.6	0.2
194	05/14/14	To	06/13/14	06/16/14	To	06/20/14	0	118754	(420)	84104	-300	-888	14	60	0.2	0.8
195	05/21/14	To	06/20/14	06/23/14	To	06/27/14	613	119367	493	84597	-88	-138	4	50	0.4	1
196	05/28/14	To	06/27/14	06/30/14	To	07/04/14	800	120167	770	85367	0	0	1	20	2	1.2
197	06/04/14	To	07/04/14	07/07/14	To	07/11/14	(475)	119692	(535)	84832	-138	-138	2	20	1.8	1.2
198	06/11/14	To	07/11/14	07/14/14	To	07/18/14	575	120267	515	85347	-225	-225	2	20	1.6	1.2
199	06/18/14	To	07/18/14	07/21/14	To	07/25/14	800	121067	710	86057	-238	-238	3	50	1	0.8
200	06/25/14	To	07/25/14	07/28/14	To	08/01/14	(350)	120717	(500)	85557	-388	-1013	5	20	1	1.2
201	07/02/14	To	08/01/14	08/04/14	To	08/08/14	538	121255	298	85855	-288	-300	8	20	1.4	0.4
202	07/09/14	To	08/08/14	08/11/14	To	08/15/14	(300)	120955	(480)	85375	-213	-413	6	50	1.2	0.2
203	07/16/14	To	08/15/14	08/18/14	To	08/22/14	1800	122755	1710	87085	0	0	3	40	1	0.8
204	07/23/14	To	08/22/14	08/25/14	To	08/29/14	(400)	122355	(670)	86415	-438	-638	9	70	0.2	0.8
205	07/30/14	To	08/29/14	09/01/14	To	09/05/14	2138	124493	1808	88223	-225	-225	11	70	0.2	0.8
206	08/06/14	To	09/05/14	09/08/14	To	09/12/14	(213)	124280	(813)	87410	-300	-888	20	70	0.2	0.8
207	08/13/14	To	09/12/14	09/15/14	To	09/19/14	1525	125805	1225	88635	-238	-425	10	30	1.4	0.6

Week	In-Sample Dates			Out-Of-Sample Dates			Osnp	Equity	NOnp\$30	NetEq	ollt	odd	Ont	N	vup	vdn
	Start	To	End	Start	To	End										
208	08/20/14	To	09/19/14	09/22/14	To	09/26/14	(1888)	123917	(2188)	86447	-738	-2113	10	30	0.4	1.6
209	08/27/14	To	09/26/14	09/29/14	To	10/03/14	563	124480	173	86620	-525	-1600	13	60	1.2	0.8

Where:

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

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

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

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

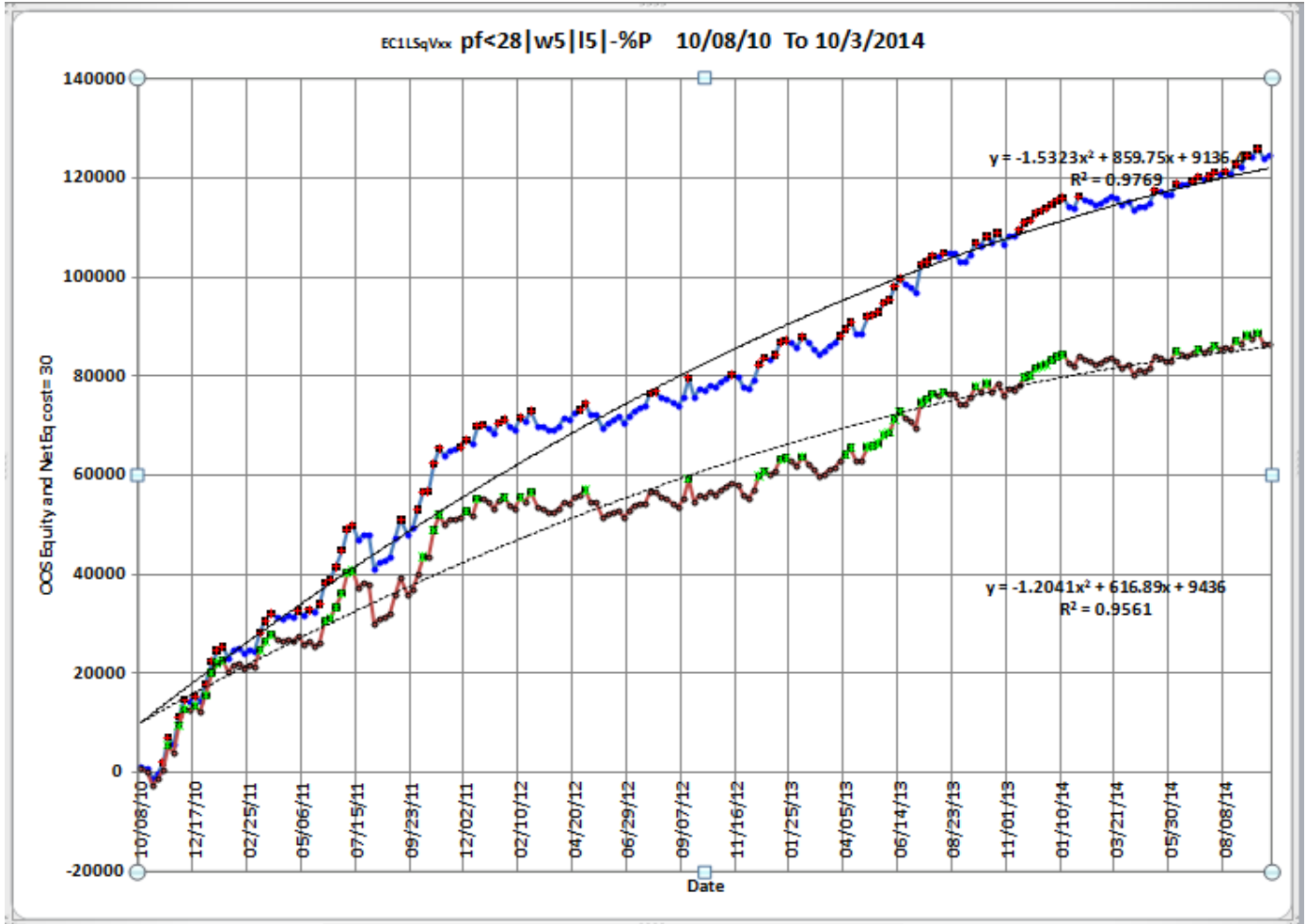
**Equity** = running sum of the weekly out-of-sample profits(Osnp)

**NetEq** = running sum of weekly out-of-sample profits minus \$30\*Ont

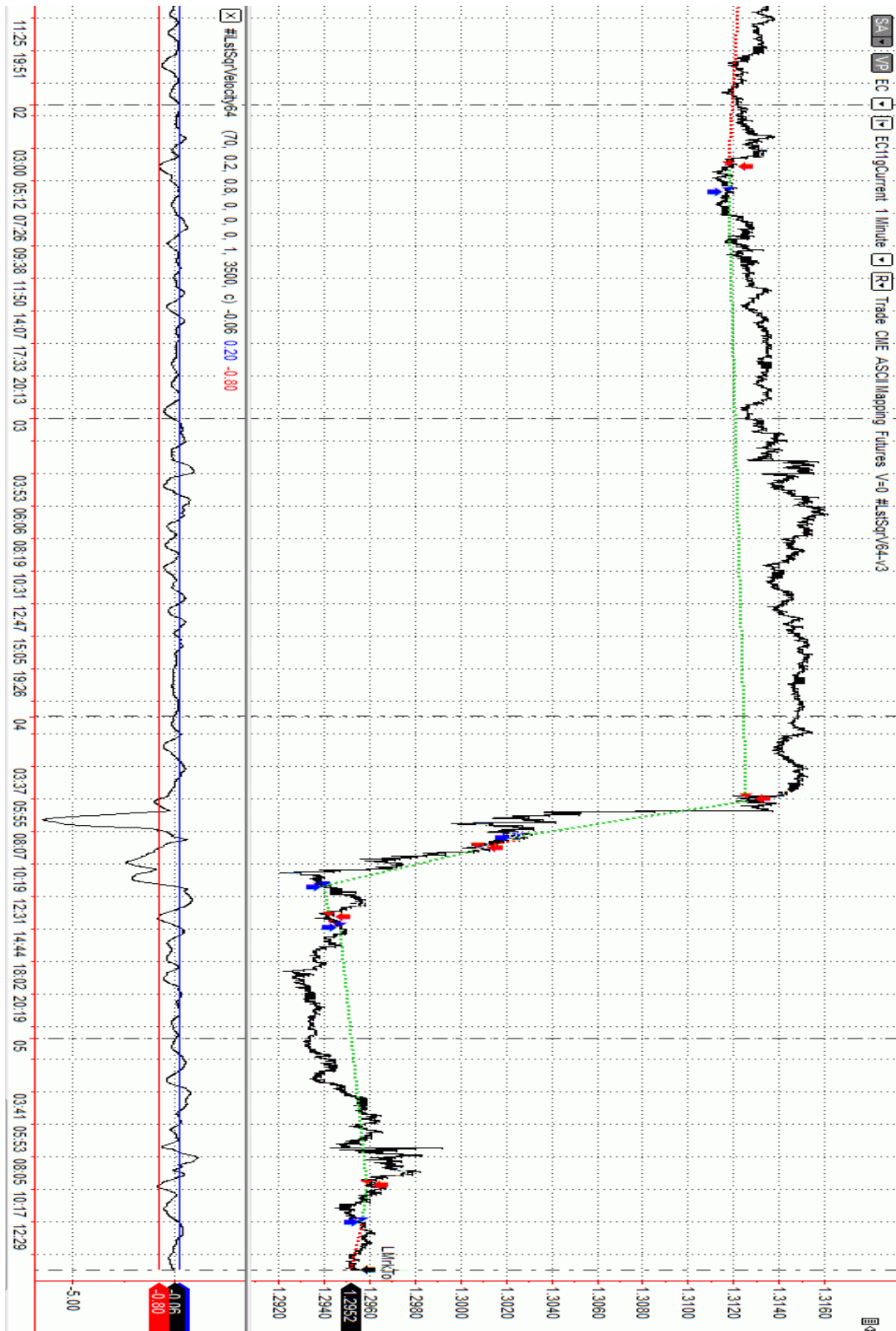
**Note:** Blank rows indicate that no out-of-sample trades were made that week

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

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



**Figure 2 Walk Forward Out-Of-Sample Performance Summary for ES1 Least Squares Velocity Strategy  
1 minute bar chart from 9/2/14-9/5/2014**



**Figure 3 Partial output of the Walk Forward Metric Performance Explorer (WFPE)  
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
1	EC1LSqVxx	s10/08/10	e10/03/14	#209	AnyTnp				a[90330]	s29321	f4464										c=\$ 30	
2	Filter-Metric	tOGP	aOGP	aOTrd	aO#T	B0	%P	t	std	LLp	eqDD	olr	#	eqTrn	eqV^2	eqR2	Dev^2	Blw	BE	eff	tOnpNet	Prob
3	pf<28 w5 15 -%P	124480	596	98.6	6	(4.0)	63	4.99	1725	-6688	-8638	4	209	538	219	95	7100	13	34	0.68	86620	7.95E-10
4	pf<26 w5 15 -%P	119955	574	93	6.2	(3.3)	63	4.74	1752	-6688	-8638	3	209	517	261	95	6956	11	37	0.69	81255	2.43E-09
5	pf<30 w5 15 -%P	112380	538	90	6	(4.1)	62	4.47	1739	-6688	-10138	5	209	440	238	96	5761	18	42	0.59	74940	8.67E-09
6	pf<36 w5 15 -%P	106827	511	92.4	5.5	(4.2)	62	4.18	1770	-6688	-8876	5	209	414	196	95	5791	13	48	0.55	72147	1.50E-08
7	pf<38 w5 15 -%P	105352	504	92.3	5.5	(4.1)	61	4.13	1766	-6688	-8876	5	209	411	175	95	5902	14	49	0.54	71092	1.84E-08
8	pf<32 w5 15 -%P	103603	496	84	5.9	(4.1)	61	4.11	1742	-6688	-9863	5	209	404	169	94	6068	22	49	0.54	66613	4.33E-08

The WFPE Filter Output Columns are defined as follows:

**Row 1** EC1LSqVxx is the strategy abbreviation, First OOS Week End Date(10/8/2010), Last OOS Week End Date(10/3/2014), **Number of weeks(#209)** a=average of bootstrap random picks. s= standard deviation of bootstrap random picks. f=number of different filters examined. c= slippage and round trip trade cost(c=\$20).

**Filter** = The filter that was run. Row 3 filter **pf<28|w5|15|-%P**

The **pf<28|w5|15|-%P** filter produced the following average 209 week statistics on row 3.

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

**aOGP** = Average oos gross profit for the 209 weeks

**aOTrd** = Average oos profit per trade

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

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

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

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

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

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

**eqDD** = The oos equity drawdown

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

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

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

**eqV^2** = The ending velocity of 2<sup>nd</sup> order polynomial that is fit to the equity curve

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



**Dev<sup>2</sup>** = 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)<sup>2</sup>]

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

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

**eff** = Efficiency. The average daily out-of-sample profit divided by the average daily in-sample profit.

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

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

## Appendix: The *Normalization Multiplier*

### What is the Multiplier ?

The Least Square 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

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

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

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

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

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

EC 1 min bars Date Range 1100830 to 1141003  
 Total Number of Bars=1383053  
 LSqVelocity Multiplier to Scale Velocity N Range to One Sd

N	SD	1/SD
20	5.22765e-005	19129.1
30	4.24570e-005	23553.2
40	3.67068e-005	27242.9
50	3.28132e-005	30475.5
60	2.99404e-005	33399.7
70	2.77044e-005	36095.3

1/SD Mult Ave=28316

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

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

**EC 1 min bars Date Range 1100830 to 1141003**  
**Total Number of Bars=1383053  $\sqrt{N}$  Norm=1**

**LSqVelocity Multiplier to Scale Velocity N Range to One SD**

<b>N</b>	<b>SD</b>	<b>1/SD</b>
<b>20</b>	<b>0.000233787</b>	<b>4277.39</b>
<b>30</b>	<b>0.000232547</b>	<b>4300.21</b>
<b>40</b>	<b>0.000232154</b>	<b>4307.49</b>
<b>50</b>	<b>0.000232024</b>	<b>4309.89</b>
<b>60</b>	<b>0.000231918</b>	<b>4311.88</b>
<b>70</b>	<b>0.000231792</b>	<b>4314.21</b>

**1/SD Mult Ave=4303.51**

As we can see the SDs are now very close. If we multiply all velocities by  $4303*\sqrt{N}$  then the SDs of the velocities for all will be normalized to 1. This allows us to do an optimization search for ranges of  $v_{up}$  and  $v_{dn}$  from 0.2 to 3 standard deviations for all N.