Using The Repeated Median Velocity Strategy
To Trade Crude Light CL 5min Bars IV
12/19/2014 to 5/30/2025

Working Paper May 2025

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.

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.

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

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

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

Recently much work has been done in what is called robust regression and outlier detection techniques, Ref [1]. Robust regression techniques are now defined by a measure called the "breakdown point". The breakdown point is loosely defined as the smallest amount of bad data points that can cause the regression coefficient solutions to take on values some distance from their true values. Unfortunately, the Least Squares technique has a breakdown point of 1/N. In other words, only one bad data point can significantly change the computation of the velocity or slope of a straight line. The median of a set of numbers has a breakdown point of 50%. This is because when 50% of the numbers are bad then there is no way of telling which are the bad numbers and which are the good numbers. 50% is the highest breakdown point.

The least absolute deviation (LAD) regression estimator from Ref [1] is:

$$\text{Minimize}(a,b) \sum_{i=1}^{i=N} \text{absolute value [err(i)]}$$

and has a breakdown point of 29.8% . For the LAD this means around ¼ of the price points can be bad before the computations of a and b become erroneous. Siegel Ref [2], in his paper "Robust regression using repeated medians", introduced a technique for finding the slope that has a 50% breakpoint. The repeated median is also described in Ref [1].

While the repeated median technique may sound complicated it is quite easy to compute. Here's how. For demonstration purposes let's suppose we have 15 data points on an x, y graph such that,

X	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Y	1	2	10	4	5	6	7	8	9	18	11	12	13	18	15	20

We've added two bad Y points at X positions 3,10, 14 and 16. To calculate the repeated median slope we would take the slope of every pair of y values and then find the median of all the pairs of slopes. For this example, we would take

slope	1	y(2)-y(1)/(2-1) =	1.00
slope	2	y(3)-y(1)/(3-1)=	4.50
slope	3	y(4)-y(1)/4-1)=	1.00
slope	4	y(5)-y(1)/(5-1)=	1.00
slope	5	y6)-y(1)/(6-1)=	1.00
slope	6	y(7)-y(1)/(7-1)=	1.00
slope	7	y(8)-y(1)/(8-1)=	1.00
slope	8	y(9)-y(1)/(9-1)=	1.00
slope	9	y(10)-y(1)/(10-1)=	1.89
slope	10	y(11)-y(1)/(11-1)=	1.00
slope	11	y(12)-y(1)/(12-1)=	1.00
slope	12	y(13)-y(1)/(13-1)=	1.00
slope	13	y(14)-y(1)/(14-1)=	1.31
slope	14	y(15)-y(1)/(15-1)=	1.00
slope	14	y(16)-y(1)/(16-1)=	1.27
		Median =	1.00

The median slope of the above is 1. The above process is repeated for:
(y(2)-y(i))/(2-i), i=1 to 15 i≠2,
(y(3)-y(i))/(3-i), i=1 to 15 i≠3,
……..
(y(16)-y(i))/(16-i), i=1 to 16 i≠16.

The final slope is then the **median of all the medians calculated above**. While the repeated median looks redundant because the very first calculation produced the correct slope, price data is not so nicely distributed as our example and the extra calculations are needed to assure that the outliers are eliminated.

The mathematical formula for the above is:

Slope(t) $= \underset{i=1 \text{ to } N}{\text{median}_i} \{ \underset{j=1 \text{ to } N}{\text{median}_{i \neq j}} [\text{price}(t)-\text{price}(t-i))/(i-j)] \}$

Figure 1 below shows a plot of the x,y numbers above with the repeated median line and the least squares line on the graph. Notice how the bad points draw the least squares line towards them while the repeated median line is completely unaffected by the outliers. The least Squares line is given by the formula **y=-0.65 + 1.1074*x** . The true line is given by the formula **y=x** . From this simple example we can observe how noise has distorted the least squares estimates of **a** and **b, where y=a+bx**.

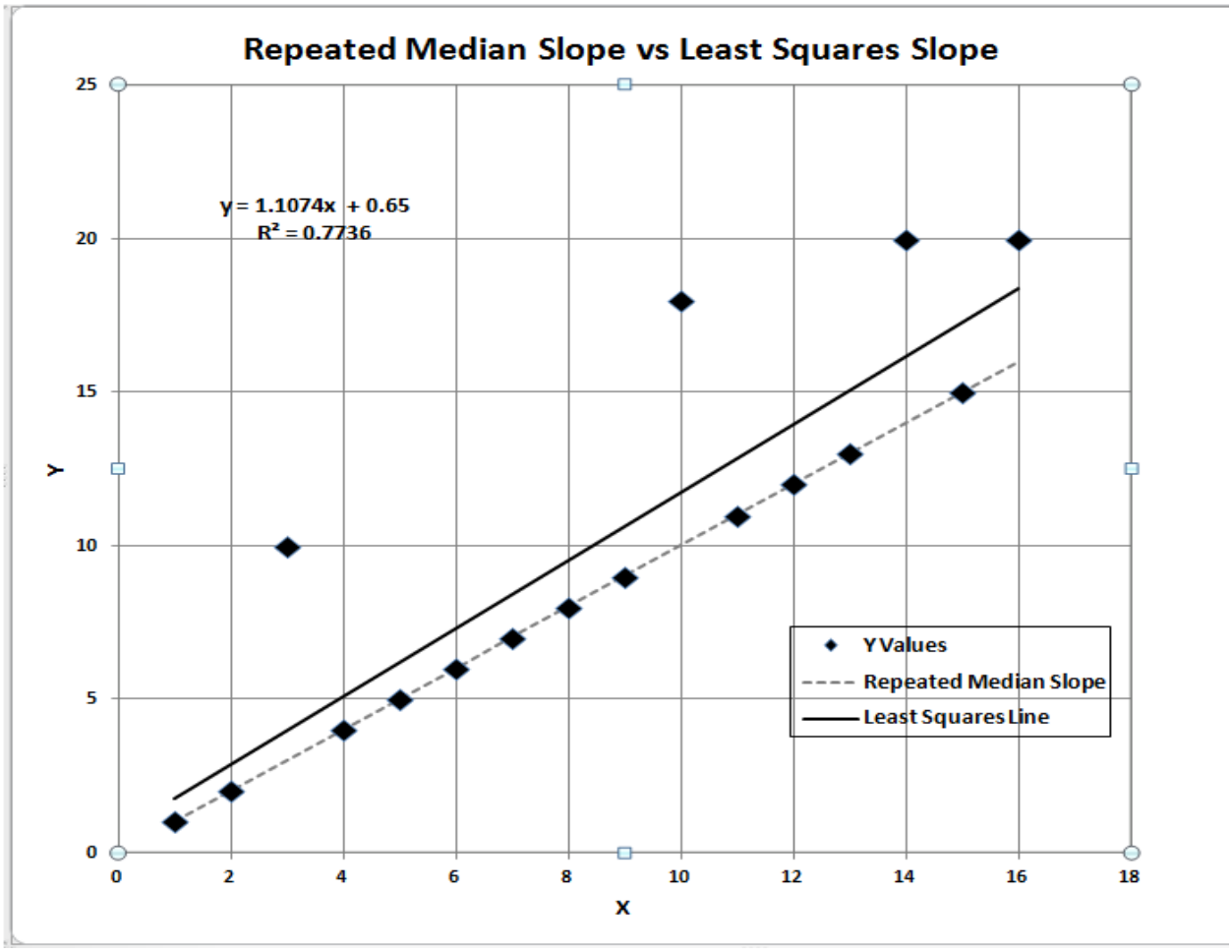

Figure 1 Repeated Median Slope vs Least Squares Slope.

The Repeated Median Velocity (RMedV) System Defined

Here we will use the repeated median slope to create a trading system. For a straight line the velocity is equal to the slope. The repeated median velocity, also called the **robust velocity,** has the advantage that it is a natural random price noise inhibitor. We can create a system such that unless the repeated median velocity using N past price bars is greater than some threshold value we will not buy or sell. A large percentage of price movements are just noise which generates a lot of back-and-forth movements of small magnitudes. This back-and-forth movement creates many false buy and sell signals. However, using the repeated median velocity over N past

prices, we will attempt to filter out many of the small price noise movements by requiring that the repeated median velocity to be greater than some threshold before we act.

At each price bar we calculate the repeated median velocity (**RMedV**) 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.

The Repeated Median Velocity Trading Strategy

Buy Rule:
IF RMedV is greater or equal to the threshold amount ***vup and RMedV[1]<vup*** then buy at the market.

Sell Rule:
IF RMedV is less or equal to the threshold amount ***-vdn*** **and RMedV[1]>-vdn** then sell at the market.

Intraday Bars Exit Rule:
Close the position at 1430 EST when the open outcry pit session ends. (no trades will be carried out overnight).

First Trade of Day Entry Rule:
All trade signals before the 9am EST open outcry pit session are ignored. We've included this rule because we observed that overnight Globex trading mostly consists of price movements with few sustainable trends. 60-70% of sustainable trends usually occur during the open outcry pit session hours. (11/10/25)Note: this is no longer true, and future strategies should include the overnight trades, and the Exit rule could still be at 1430.

Data Discussion
To test this strategy, we will use 5-minute bar prices of the Crude Light futures contract traded on the NYMEX WTI and Globex and known by the symbol ***CL*** for the 546 weeks from December 19, 2014, to May 30, 2025.

We will test this strategy with the above CL 5min bars on a walk forward basis, as will be described below. In TradeStation (TS) or MultiCharts(MC), we will run the RMedV Strategy on the CL 5 min bar data from December 19, 2014, to May 30, 2025. We will break up and create 30-day calendar ***in-sample*** sections along with their corresponding one calendar week ***out-of-sample*** sections from the 546 weeks of CL (see Walk forward Testing below) creating 546 out-of-sample weeks. To create our walk forward files we will use the ***add-in*** software product called the Power Walk Forward Optimizer (PWFO) http://meyersanalytics.com/Walk-Forward-Optimization.html . In TS/MC, we will run the PWFO strategy ***add-in*** along with the RMedV Strategy on the CL 5min data from 12/19/2014 to 5/30/2025. The PWFO will breakup and create 30-day calendar in-sample sections along with their corresponding one calendar week out-of-sample sections from the 546 weeks of CL (see Walk Forward Testing below) creating 546 out-of-sample weeks. Note the first in-sample week will be from 11/13/2014 to 12/12/2014 and the first out-of-sample week will be from 12/16/14 to 12/19/14.

Testing the Repeated Median Velocity System (RMedV)

Using Walk Forward Optimization

There are three strategy inputs to determine:

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

We will test the RMedV strategy with the above CL 5 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 an ***in-sample*** 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 usually 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're 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 in-sample 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 case 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 the number of out-of-sample sections 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 on average. ***Mathematical note: This assumption assumes that the out-of-sample returns are from probability distributions that have a finite variance.***

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

In order to gain confidence that our input parameter selection method using the optimization output of the in-sample data will produce profits, we must test the input parameters we found in the in-sample section on out-of-sample data. In addition, we must perform the in-sample/out-of-sample analysis many times. Why not just do the out-of-sample analysis once or just 10 times? Well just as in Poker or any card game, where there is considerable variation in luck from hand to hand, walk forward out-of-sample analysis gives 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 (>50) 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, vdn* .

For the test data we will run the Multicharts64 optimization engine on **CL 5** min price bars from 11/13/2014 to 5/30/2025 with the below optimization ranges for the RMedV strategy inputs. We will create a 30-calendar day in-sample periods each followed by a 7 day out-of-sample period (See Table 1 for the in-sample/out-of-sample periods). This will create 546 in-sample 30-day periods followed by 546 out-of-sample 7-day periods from 11/13/2014 to 5/30/2025.

We will use the following strategy input optimization ranges.

N from 3 to 24 in steps of 1
vup from 0.25 to 3.5 steps of 0.25
vdn from 0.25 to 3.5 in steps of 0.25
Intraday Bars Exit Rule:
Close the position at 1430 EST when the open outcry pit session ends. (no trades will be carried overnight).

First Trade of Day Entry Rule:
All trade signals before the 9am EST open outcry pit session are ignored. We've included this rule because we observed that overnight Globex trading mostly consists of price movements with few sustainable trends. 60-70% of sustainable trends usually occur during the open outcry pit session hours.

Mult=6.7*√N. Note: this normalizes the RMedV 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 1*** for a detailed explanation.

This will produce 4508 different input combinations or cases of strategy input parameters. for each of the 546 in-sample/out-of-sample files for approximately 10+ years of 5 min bar CL prices from 11/13/2014 to 5/30/2025.

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 gives 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 an 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 in-sample selection of strategy inputs.

The combination metric filters are found by a program called WFME64v8xb. Details of this program can be found at **https://meyersanalytics.com/wfme.html.**

All PWFO file metrics used by the WFME64v8x are described at **https://meyersanalytics.com/Walk-Forward-Optimization.html** .

We will use the WFME64 v8xb program to find one in-sample combination-metric filter applied to each in-sample section which gives a set of strategy inputs which are then applied to each following out-of-sample section This will consist of 517 in-sample and out-of-sample sections From 12/19/14 to 11/8/24. We will leave the 29 sections, 6+ months of CL data from 11/15/24 to 5/30/2025 out of the WFME64 calculations so that we can see how the metric filters found by the WFME64 performed on these 29 following *future* weeks which were not included in the original WFME64 run. Why 29 weeks instead of 26 weeks? I originally did the work ending on 5/9/25 but forgot to write it up until June 3rd. So, I then added 3 more weeks to the run to make it more current. Hence 29 weeks.

Here is a metric combination ***filter*** found by the WFME64 v8x program that was used in this paper. We also wish to limit the number losing trades in a row (**lr**) in the ***IS*** period to 3 or less (**lr≤3**). In addition, we want the R2 equity trend line correction to be <50, **r2<50**. Using **lr-r2** elimination screen, as described, there can still be 100's of rows left in the in-sample section. The PWFO generates the performance metric named **mLb**. This metric, **mLb,** is the **Median of the Number of Bars in Losing Trades.** Each losing trade takes a certain number of time bars. If we order the number of bars each losing trade takes, then the median of all the losing trade bars is a robust statistic. We take the median of the losing trades bars to minimize the effect of large and small losing trade bars that may be outliers that distort this statistic. . Let us choose the 1**0** rows in the in-sample section that contain the **minimum mLb** values from the rows that are left from the **lr-r2** screen. In other words, we sort **mLb** from low to high, eliminate the rows that have **lr>3**, **r2>50** and then choose the 10 rows of whatever is left. This filter will now leave 10 cases or rows in the in-sample section that satisfy the above filter conditions. We call this filter **b10mLb |lr≤3r2≤50** where **b10mLb** means the bottom or minimum **10 mLb** rows left ***after*** the **lr-r2** in-sample row elimination. Suppose for this filter, within the 10 in-sample rows that are left, we want the row that has the smallest value of the metric called **mLTr. mLTr -Median of The Losing Trades.** This is the median of the losing trade losses. We take the median of the losing trades to minimize the effect of large losing trades that may be outliers that are not repeatable.
We abbreviate this final filter as **b10mLb |lr≤3r2≤50-mLTr.** For each in-sample section this filter leaves only one row in the in-sample section with its associated strategy inputs and following out-of-sample net profit in the out-of-sample section using the strategy inputs found in the in-sample section. This **b10mLb |lr≤3r2≤50-mLTr filter** is then applied to each of the 517 in-sample sections which give 5178 sets of strategy inputs that are used to produce the corresponding 517 out-of-sample performance results. The average out-of-sample performance is calculated from these 517 out-of-sample performance results. In addition, many other important out-of-sample performance statistics for this filter are calculated and summarized.

Figure 2 shows such a computer run along with a small sample of other WFME64 filter combinations that are constructed in a similar manner. **Row 4** of the sample output in **Figure 2** shows the results of the filter discussed above. We choose row 4 instead of row 3 because the largest losing week(LLP) was much lower.

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 for each of the 5000 mirror filters. 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 5000-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 2** lists the 5000-mirror filter's bootstrap average for our 517 out-of-sample files of **65.3** with a bootstrap standard deviation of **$67.3**. (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/517) and the average net weekly for the filter from **Figure 2, Row 4** would be the **filter toNP/ (# of OOS)** periods traded or **176932/501=396.7**. The probability of obtaining our filters average weekly net profit of **396.7** is **$4.27x10^{-7}$** which is **4.92** standard deviations from the bootstrap average. For our filter, in Row 4, the expected number of cases that we could obtain by pure chance that would match or exceed **$396.7 is $[1-(1- 4.27x10^{-7})^{115320} \approx 115320 \text{ x } 4.27x10^{-7} = 0.049$** where **115320** is the total number of different filters we looked at in the WFME64v8x run. This number is much less than one, so it is improbable that any random filter would beat our results or that our filter's result of $176932 was due to pure chance.

Results

Figure 1 presents a graph of the equity curve generated by using the WFME64 filter on the 517 weeks ending 12/19/14 – 11/08/24 and the equity curve on the 29 weeks following until 5/30/25 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 CL weekly closing prices superimposed on the Equity Chart. The vertically dotted red line on the right separates the future excluded period equity from 11/15/24 to 5/30/225. This is what would have happened if you used the strategy inputs found by the filter **b10mLb |lr≤3r2≤50** on data not included in the initial run.

Figure 2 shows such a computer run along with a small sample of other WFME64 filter combinations that are constructed in a similar manner. **Row 4** of the sample output in **Figure 2** shows the results of the filter used and discussed above.

Figure 3 presents the out-of-sample CL 5-minute bar chart of all the buy and sell signals of the WFME64 filter 8/1/24 to 8/9/24 with the RMedV Indicator or those dates.

Table 1 below presents a table of the 517 plus the 29 future weeks in-sample and out-of-sample dates, the WFME **Filter** selected strategy inputs and the weekly out-of-sample profit/loss results using the **b10mLb |lr≤3r2≤50 filter** described above.

Discussion of Strategy Performance of the WFME64 run.

In **Figure 2, Row 3** is the filter chosen, **b10mLb |lr≤3r2≤80**. This Metric Filter produced $176932 net profits after costs in 5178 weeks and $7152 net profits after costs in the withheld 29 weeks from the initial WFME run. The spreadsheet columns present some statistics that are of interest for the filter. An interesting statistic is **Blw**. **Blw** is the maximum number of weeks the **OOS** equity curve for this filter failed to make a new high. Blw is 49 weeks for this filter. This means that 49 weeks, almost a year from 10/14/16 to 9/29/17, was the longest time that the equity for this strategy failed to make a new equity high in the 517 out-of-sample weeks. Note that this was at the beginning of the price data and the drawdown was ($5630). For this strategy, the **%P** (% of weekly oos periods that are positive) was **57%**, and the **%Wtr** (The % of all oos trades that are positive) was **45%**. This low **%Wtr** was made up for by **oW/oL** (average oos winning trades/average oos losing trades) equal to 1.55.

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 and trading conditions in the in-sample sample. In addition, notice how often ***N*** changes from 3 to 24. When the data gets very noisy with a lot of spurious price movements, the look back period, N, should be higher. During other times when the noise level is not as much N can be lower to get onboard a trend faster.

Figure 1 presents a graph of the equity curve using the **b10mLb |lr≤3r2≤50 filter** on the 517 weeks of out-of-sample data. Notice how the equity curve follows the 2nd order polynomial trend line with an R^2 of 0.95. This R^2 dropped to 0.93 for the net equity curve.

Using this filter, the strategy generated a profit of $184,084 net equity after commissions and slippage of $13/trade trading one CL contract for a total of 546 weeks. For slippage I used $10 roundtrip and for commissions round trip, I used $3. From **Table 1**, the largest losing week was -$6640 on the week ending 3/25/2022. The largest drawdown was -$10970 from the week ending on 6/25/21 to 10/29/21. This drawdown lasted 18 weeks and took 5 weeks to make a new high in equity. The ***future*** period of 11/15/24 to 10/30/25 that was not included in the WFME64 run was a small range market yet the RMedV strategy/WFME filter did well making a net profit of $8790 before commissions and slippage during that half-year time frame.

In observing Table 1 we can see that this strategy and filter made trades from a low of no trades per week in 71 of the 517 weeks to a high of 36 trades/week with an average of 8.02 trades/week in the weeks it did trade.

This is the 4th paper where we used the RMedV strategy to trade CL 5min bars.
In this paper the filter was **b10mlb|lr<3|r2<50-mLTr**

The 3rd paper,
Using The Repeated Median Velocity Strategy To Trade Crude Light CL 5min Bars III
3/14/2014 to 8/09/2024 Working Paper August 2024
https://meyersanalytics.com/publications2/CL5RMedV-3.pdf
In this paper the filter was **b10mlb|p<5|lr<3|r2<50-mLTr**.

The 2nd paper,
Using The Repeated Median Velocity Strategy To Trade Crude Light CL 5min Bars II
1/2/2013 to 5/26/2023 Working Paper June 2023

https://meyersanalytics.com/publications2/CL5RMedV-2.pdf
In this paper the filter was **b50mlb|p<4|lr<3|r2<80-mLTr**.

The 1st paper,
Trading the Crude Light CL 5min Bars With The Repeated Median Velocity Strategy 1/2/2008 to 6/10/2019, Working Paper June 2019,
https://meyersanalytics.com/publications2/CL5RMedV.pdf
In this paper the filter was **t20t|p≤4|lr≤3-mDev** which is quite different than the filter found in the previous 2 papers.

This means that due to changing macro conditions over time and due to different traders in the OIL space, let alone advances in computers and trading methodology that the metric filter is going to change over time. Thus, the current paper's methodology should be run every 6+ months to engage in CL trading changes.

In addition, I eliminated overnight trading from 1430pm to 900am EST. I did this because in the past most trading in OIL was done during the open NYS. This should be investigated, mainly because a number of big moves in CL occurred outside this time range as can be seen in the chart on page16.

Lastly why 10years of 5min data? Why not 5 years or 3 years? This is just a bias from the author. Maybe shorter time periods in years may produce better out-of-sample results.

For all you who have read this paper and put up with the complex math wishing you good luck in your trading.

References

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https://meyersanalytics.com/publications2/CL5RMedV-2.pdf

Figure 1 Graph of RMedV Strategy OOS Net Equity Applying the WFME64 Filter Each Week to In-Sample RMedV CL5min Bar Prices 12/19/2014 to 10/30/225.

Note: The blue line is the equity curve without commissions and the red dots on the blue line are new highs in equity. The brown line is the equity curve with commissions of $13/round trip trade and the green dots are the new highs in net equity. The grey line is the CL Weekly Closing prices superimposed on the Equity Chart. The vertical dotted red line on the right separates the future excluded period equity from 11/15/24 to 10/30/25. This is what would have happened if you used b10mLb |lr≤3r2≤50 filter on the 3 months following the 12/19/14-11/8/24 analysis period on future CL prices which was not included in the WFME filter run. The grey line is the CL weekly prices from 12/19/14 to 05/30/25

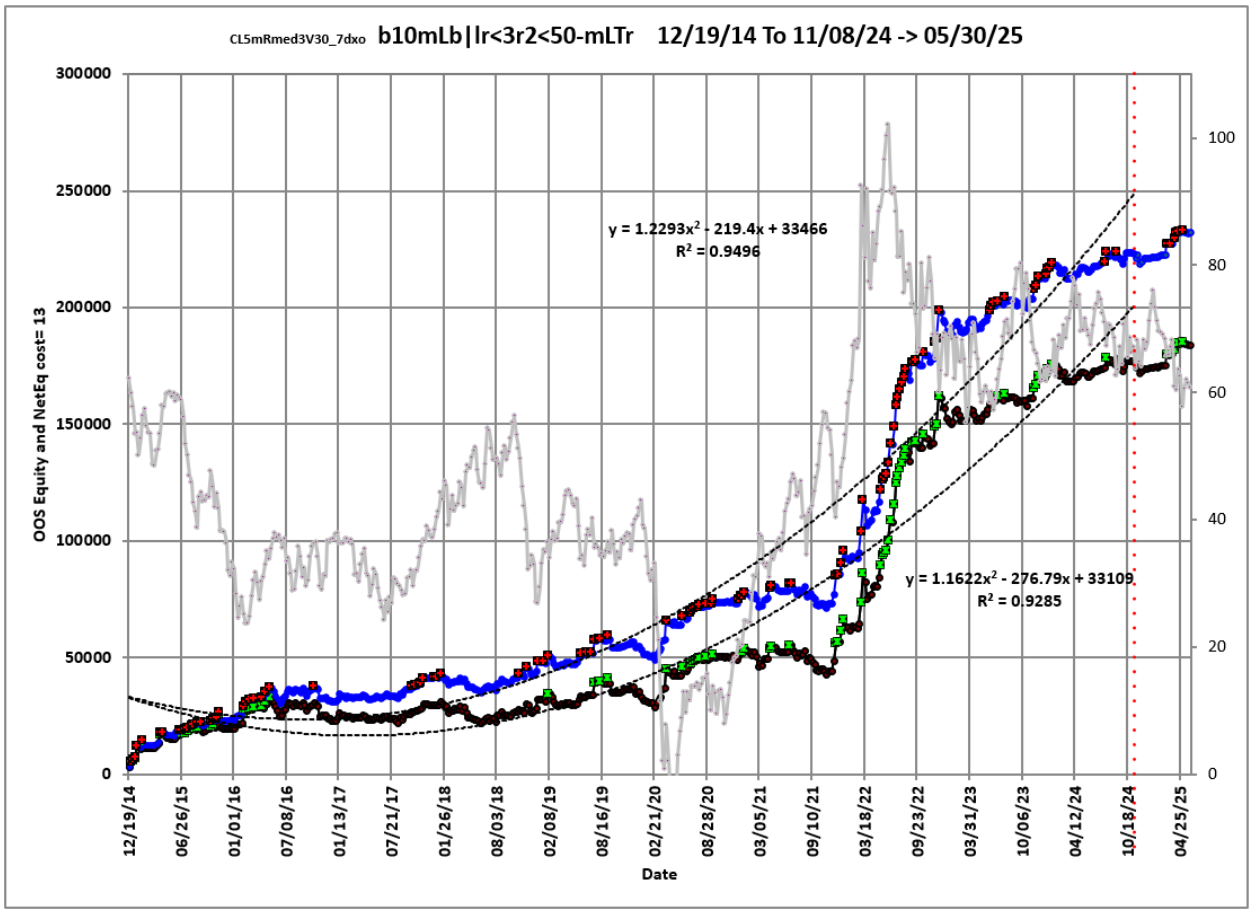

Figure 2 **Partial output of the Walk Forward Metric Explorer (WFME64 v8X)**
CL 5 min bars RMedV Velocity Strategy

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	CL5mRmed3V30-7dxo	s12/19/14	e11/08/24	#517	AnyTnp	#29					ISnt2		
2	Filter-Metric	toGP	toNP	aoGP	aoTr	ao#T	#	std	skew	kur	t	oW|oL	%Wtr
3	b20mLb|pf<4|lr<3r2<60-mLTr	227110	179322	492	61.8	7.96	462	2229	1.187	8.9	4.74	1.51	46
4	b10mLb|lr<3r2<50-mLTr	223420	176932	501	62.5	8.02	446	2121	1.694	9.99	4.99	1.55	45
5	b10mLb|pf<5|lr<3r2<50-mLTr	225620	176337	488	59.5	8.21	462	2104	1.672	10.04	4.99	1.55	45
6	b20mLb|pf<5|lr<3r2<60-mLTr	222650	174992	481	60.7	7.92	463	2223	1.208	9.01	4.65	1.51	46
7	b20mLb|pf<4|lr<3-PF	209140	173559	467	76.4	6.11	448	1907	1.687	11.67	5.18	1.47	47
8	b10mLb|pf<4|lr<3r2<50-mLTr	220150	170204	477	57.3	8.32	462	2121	1.65	9.79	4.83	1.54	45
9	b20mLb|pf<2|lr<3r2<50-std	219140	167491	478	55.2	8.67	458	1997	1.075	7.31	5.13	1.55	45
10	t20wr|lr<3r2<60-std	210240	167327	419	63.7	6.58	502	2072	1.817	17.64	4.53	1.34	49
11	t20mWb|mLb|pf<4|lr<3-PF	199760	166870	448	79	5.67	446	2057	2.693	20.49	4.6	1.45	48
12	t20wr|pf<5|lr<3r2<60-std	209620	166694	418	63.5	6.58	502	2072	1.818	17.63	4.51	1.34	49
13	b10mLb|pf<4|lr<3r2<50-std	214810	162563	471	53.4	8.81	456	2113	1.393	9.18	4.76	1.58	44
14	b20mLb|lr<3r2<60-mLTr	206070	162156	462	61	7.57	446	2243	1.223	9.02	4.35	1.53	45
15	b20mLb|pf<2|lr<3r2<60-std	215820	161740	470	51.9	9.06	459	1962	0.847	6.64	5.13	1.54	45

	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
1	a65.3	s67.3						c=$13					f115320	|	s11/15/24	e05/30/25	#29			t546
2	%P	LLtr	LLp	eqDD	wpr	lpr	v20	KTau	eqR2	Blw	BE	tkr|bl	Prob	|	toGPx	toNPx	aoTRx	aoNTx	#x	tOnpNet
3	55	-3540	-9140	-12750	8	7	216	90	87	60	97	640	8.12E-07	|	6870	4738	42	7.1	23	184060
4	57	-3540	-6640	-10970	8	9	371	93	82	49	87	889	4.27E-07	|	8790	7152	70	6	21	184084
5	57	-3540	-6640	-11540	8	9	391	93	82	49	87	892	1.31E-06	|	7500	5706	54	6.6	21	182043
6	55	-3540	-9140	-13330	8	7	168	90	87	60	100	603	1.71E-06	|	8350	6491	58	6.5	22	181483
7	57	-3540	-6630	-21560	8	6	156	95	91	43	81	1281	8.57E-07	|	6380	5288	76	4.2	20	178847
8	56	-3540	-6640	-10970	8	9	426	92	81	55	93	704	3.36E-06	|	6560	4545	42	7	22	174749
9	60	-3630	-6960	-11830	10	5	373	95	87	42	83	1214	4.06E-06	|	5590	3250	31	7.5	24	170741
10	60	-2940	-9140	-12930	10	5	308	96	90	41	106	896	3.43E-05	|	8420	6327	52	5.8	28	173654
11	56	-3030	-6610	-10440	8	6	181	95	93	44	103	897	2.24E-06	|	8740	7882	132	3.5	19	174752
12	60	-2940	-9140	-12930	10	5	306	96	90	41	107	887	3.71E-05	|	6050	3866	36	6	28	170560
13	56	-3540	-6960	-11830	13	6	517	91	85	50	96	767	7.61E-06	|	5300	3025	30	7.6	23	165588
14	55	-3540	-9140	-14220	8	6	172	89	85	60	115	480	4.70E-06	|	10070	8263	72	6.3	22	170419
15	61	-3630	-6960	-12180	13	5	384	95	89	41	82	1275	1.00E-05	|	4590	2380	27	7.1	24	164120

The WFME64 v8X AVE File Output Cols are defined as follows.

- ***Row 1***

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

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

  Row 1 Col AB: Future PWFO File Start Date
  Row 1 Col AC: Future PWFO File End Date
  Row 1 Col AD: Future Number of PWFO Files not included in the WFME64 run (weeks)
  Row 1 Col AG: Number of Total oos-future PWFO Files

- ***Row 2*** **to Last Row Columns: A through AG**

  Col A: ***The Strategy Input/Filter Names*** Example Row 4: **b10mLb|lr≤3r2≤50**:
  Col B: ***toGP -*** Total out-of-sample(oos) gross profit for these 517 oos periods (= weeks).
  Col C: ***toNP -*** Total out-of-sample(oos) Net profit (toGP-Number of Trade Weeks*cost) for the 517 oos periods.
  Col D: ***aoGP -*** Average oos gross profit for the 517 # oos periods
  Col E: ***aoTr -*** Average oos profit per trade
  Col F: ***ao#T -*** Average number of oos trades per week

Col G: ***# -*** The number of oos periods this filter produced a profit or loss. Note for some oos periods there can be no strategy inputs that satisfy a given filters criteria and no trades will be made during that period.
Col H: ***std -*** he standard deviation of the 517 oos period profits and losses
Col I: ***skew -*** The Skew statistic of the 517 oos period profits and losses
Col J: ***kur -*** he kurtosis statistic of the 517 oos period profits and losses
Col K: ***t -*** The student t statistic for the 517 oos periods. The higher the t statistic the higher the probability that this result was not due to pure chance.
Col L: ***oW|oL -*** Ratio of average oos winning trades divided by average oos losing trades.
Col M: ***%Wtr -*** he percentage if oos winning trades.
Col N: ***%P -*** percent of all oos periods that were profitable.
Col O: ***LLTr*** Largest Losing Trade.
Col P: ***LLp -*** The largest losing oos period
Col Q: ***eqDD -*** The oos equity drawdown
Col R: ***wpr -*** The largest number of winning oos periods (weeks) in a row.
Col S: ***lpr -*** the largest number of losing oos periods in a row.
COLT: ***v20 –*** the equity velocity for the latest 20 periods
Col U: ***KTau^2 -*** The Kendall rank coefficient is often used as a test statistic in a statistical hypothesis test to establish whether two variables may be regarded as statistically dependent. This test is non-parametric, as it does not rely on any assumptions on the distributions of X or Y or the distribution of (X,Y)
Col V ***eqR2 -*** The correlation coefficient(R^2) of a straight-line fit to the equity curve.
Col W: ***Blw -*** The maximum number of oos periods the oos equity curve failed to make a new high.
Col X: ***BE -*** Break even in oos periods. Assuming the average and standard deviation are from a normal distribution, this is the number of oos periods you would have to trade to have a 98% probability that your oos equity is above zero.
Col Y: ***tkr|bl*** = t*ktau*eqR2/BE a measure of how good the filter fit is.
Col Z: ***Prob -*** The probability that the filters toNP was due to pure chance. Should be multiplied by the total number of filters examined (Row 1, Col Z)

Col AB: ***toGPx*** Total gross profit for the 26 future excluded periods (for this run periods = weeks).
Col AC: ***toNPx*** Total Net profit {toGP-Number of Trade Weeks(#)*cost} for the 26 future excluded periods.
Col AD: ***aoTrx*** Average profit per trade for the 26 future excluded periods
Col AE: ***aoNTx*** Average number of trades per week for the 26 future excluded periods
Col AF: ***#x*** the number of the 26 future excluded periods this strategy/filter traded. Note for some periods there can be no strategy inputs/filter that satisfy the Strategy Inputs/Filter criteria and no trades will be made during that period.
Col AG: ***tOnpNet -*** toNP+toNPx = Total Net Profits of oos+future periods

Figure 3 The out-of-sample 5-minute bar chart of all the RMedV Strategy buy and sell signals of the WFME64 filter with the RMedV Indicator.
7/30/24 to 8/2/24

Table 1 Walk Forward Out-Of-Sample Performance Summary
CL-5 min bars RMedV Strategy with WFME64 Filter

CL 5 min bars 12/19/2014 - 10/30/24 OOS weekly performance using the filter below on each in-sample segment. The input values *N, vup, vdn* are the values found from applying the filter to the in-sample section and used on the following out-of-sample section.

In-sample Section Filter: b10mlb|lr<3|r2<50-mLTr

Where:
ogp = Weekly Out-of-sample gross profit in $
ont = The number of trades in the out-of-sample week.
ollt = The largest losing trade in the out-of-sample section in $.
odd = The drawdown in the out-of-sample section in $.
Equity = Running Sum of weekly out-of-sample gross profits $
osnp$20 = Weekly Out-Of-Sample Net Profit in $ = **ogp-ont*13**
NetEq = running sum of the weekly out-of-sample net profits (NOnp$13)
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$13	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
11/12/14	12/12/14	12/15/14	12/19/14	3460	3408	4	3460	4	0	0	3460	3408	9	2	3.5
11/19/14	12/19/14	12/22/14	12/26/14	1990	1938	4	2870	3	-880	-880	5450	5346	7	0.5	1.75
11/26/14	12/26/14	12/29/14	01/02/15	960	804	12	2270	7	-480	-950	6410	6150	7	0.5	1.75
12/03/14	01/02/15	01/05/15	01/09/15	870	779	7	1770	4	-520	-850	7280	6929	3	2.75	0.25
12/10/14	01/09/15	01/12/15	01/16/15	5200	5161	3	5200	3	0	0	12480	12090	16	1.75	2.75
12/17/14	01/16/15	01/19/15	01/23/15	0	0	0	0	0	0	0	12480	12090	15	2	2.75
12/24/14	01/23/15	01/26/15	01/30/15	(820)	(924)	8	3060	3	-1960	-2900	11660	11166	4	2.25	1.25
12/31/14	01/30/15	02/02/15	02/06/15	2810	2576	18	7200	8	-1130	-1730	14470	13742	7	1.75	0.25
01/07/15	02/06/15	02/09/15	02/13/15	(2020)	(2046)	2	0	0	-1030	-2020	12450	11696	10	3.5	2.75
01/14/15	02/13/15	02/16/15	02/20/15	0	0	0	0	0	0	0	12450	11696	19	3.5	3
01/21/15	02/20/15	02/23/15	02/27/15	0	0	0	0	0	0	0	12450	11696	18	3.5	3
01/28/15	02/27/15	03/02/15	03/06/15	0	0	0	0	0	0	0	12450	11696	18	3.5	3
02/04/15	03/06/15	03/09/15	03/13/15	0	0	0	0	0	0	0	12450	11696	11	2.5	3.25
02/11/15	03/13/15	03/16/15	03/20/15	(70)	(83)	1	0	0	-70	-70	12380	11613	11	2.5	3.25
02/18/15	03/20/15	03/23/15	03/27/15	770	757	1	770	1	0	0	13150	12370	10	2.5	2.25
02/25/15	03/27/15	03/30/15	04/03/15	1040	1027	1	1040	1	0	0	14190	13397	10	2.5	2.25
03/04/15	04/03/15	04/06/15	04/10/15	3870	3831	3	3870	3	0	0	18060	17228	3	3.5	2.75
03/11/15	04/10/15	04/13/15	04/17/15	220	181	3	1650	2	-1430	-1430	18280	17409	3	3.5	2.5
03/18/15	04/17/15	04/20/15	04/24/15	(360)	(425)	5	350	2	-410	-500	17920	16984	12	2	1
03/25/15	04/24/15	04/27/15	05/01/15	(1040)	(1092)	4	0	0	-820	-1040	16880	15892	5	3.25	1.75
04/01/15	05/01/15	05/04/15	05/08/15	130	78	4	1410	2	-940	-940	17010	15970	17	3	1.5
04/08/15	05/08/15	05/11/15	05/15/15	(370)	(435)	5	1310	3	-990	-990	16640	15535	3	3	1.25
04/15/15	05/15/15	05/18/15	05/22/15	10	(68)	6	1270	3	-800	-1260	16650	15467	10	1.5	0.25
04/22/15	05/22/15	05/25/15	05/29/15	(160)	(199)	3	360	2	-520	-520	16490	15268	11	2.5	0.75
04/29/15	05/29/15	06/01/15	06/05/15	1610	1441	13	3330	6	-550	-950	18100	16709	10	0.5	1
05/06/15	06/05/15	06/08/15	06/12/15	180	102	6	520	3	-150	-300	18280	16811	18	1	0.25
05/13/15	06/12/15	06/15/15	06/19/15	610	584	2	610	2	0	0	18890	17395	8	2	2.25
05/20/15	06/19/15	06/22/15	06/26/15	350	337	1	350	1	0	0	19240	17732	7	2.5	3.25
05/27/15	06/26/15	06/29/15	07/03/15	0	0	0	0	0	0	0	19240	17732	10	2	2.5
06/03/15	07/03/15	07/06/15	07/10/15	130	26	8	1590	5	-790	-880	19370	17758	9	1.25	2
06/10/15	07/10/15	07/13/15	07/17/15	850	837	1	850	1	0	0	20220	18595	3	2.75	2.5
06/17/15	07/17/15	07/20/15	07/24/15	0	0	0	0	0	0	0	20220	18595	3	2.75	2.5
06/24/15	07/24/15	07/27/15	07/31/15	940	797	11	2120	6	-730	-730	21160	19392	6	1.25	0.75
07/01/15	07/31/15	08/03/15	08/07/15	430	300	10	2040	4	-320	-730	21590	19692	16	0.5	0.5
07/08/15	08/07/15	08/10/15	08/14/15	(220)	(285)	5	520	2	-360	-500	21370	19407	6	1.75	1.25
07/15/15	08/14/15	08/17/15	08/21/15	850	824	2	850	2	0	0	22220	20231	16	1.5	1
07/22/15	08/21/15	08/24/15	08/28/15	(270)	(530)	20	3670	9	-960	-1240	21950	19701	6	1.5	0.25
07/29/15	08/28/15	08/31/15	09/04/15	610	428	14	6020	7	-1600	-2470	22560	20129	3	3	2.75
08/05/15	09/04/15	09/07/15	09/11/15	(1810)	(1836)	2	0	0	-1510	-1810	20750	18293	6	3	2.5

In-Sample Dates		Out-of-Sample Dates		osnp	NOnp$13	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
08/12/15	09/11/15	09/14/15	09/18/15	290	277	1	290	1	0	0	21040	18570	6	2.75	3.25
08/19/15	09/18/15	09/21/15	09/25/15	1200	1187	1	1200	1	0	0	22240	19757	6	3	3.25
08/26/15	09/25/15	09/28/15	10/02/15	270	218	4	1480	3	-1210	-1210	22510	19975	4	3.25	2
09/02/15	10/02/15	10/05/15	10/09/15	550	511	3	1030	1	-380	-380	23060	20486	4	2.75	2.75
09/09/15	10/09/15	10/12/15	10/16/15	940	758	14	3640	6	-660	-1630	24000	21244	19	0.25	0.25
09/16/15	10/16/15	10/19/15	10/23/15	(1080)	(1158)	6	110	2	-460	-1190	22920	20086	7	0.25	1.75
09/23/15	10/23/15	10/26/15	10/30/15	1220	1090	10	2870	3	-360	-1040	24140	21176	19	0.25	0.5
09/30/15	10/30/15	11/02/15	11/06/15	2750	2633	9	2980	6	-100	-100	26890	23809	20	0.25	0.75
10/07/15	11/06/15	11/09/15	11/13/15	(3530)	(3712)	14	670	2	-850	-3530	23360	20097	18	0.25	0.75
10/14/15	11/13/15	11/16/15	11/20/15	(390)	(416)	2	270	1	-660	-660	22970	19681	21	1.75	2.25
10/21/15	11/20/15	11/23/15	11/27/15	0	0	0	0	0	0	0	22970	19681	6	3.25	2.25
10/28/15	11/27/15	11/30/15	12/04/15	190	86	8	1810	3	-1020	-1570	23160	19767	5	2	0.25
11/04/15	12/04/15	12/07/15	12/11/15	10	(16)	2	960	1	-950	-950	23170	19751	6	2.75	2
11/11/15	12/11/15	12/14/15	12/18/15	230	217	1	230	1	0	0	23400	19968	15	2	1.5
11/18/15	12/18/15	12/21/15	12/25/15	0	0	0	0	0	0	0	23400	19968	15	2	1.5
11/25/15	12/25/15	12/28/15	01/01/16	(70)	(83)	1	0	0	-70	-70	23330	19885	3	2.5	1.75
12/02/15	01/01/16	01/04/16	01/08/16	1510	1458	4	1910	3	-400	-400	24840	21343	5	2.5	1.5
12/09/15	01/08/16	01/11/16	01/15/16	540	488	4	910	2	-230	-370	25380	21831	5	2.5	2
12/16/15	01/15/16	01/18/16	01/22/16	0	0	0	0	0	0	0	25380	21831	8	2.5	2.75
12/23/15	01/22/16	01/25/16	01/29/16	210	184	2	830	1	-620	-620	25590	22015	8	2.5	2.75
12/30/15	01/29/16	02/01/16	02/05/16	3710	3632	6	4210	5	-500	-500	29300	25647	4	3	1.5
01/06/16	02/05/16	02/08/16	02/12/16	1930	1852	6	2800	4	-470	-470	31230	27499	4	3	1.5
01/13/16	02/12/16	02/15/16	02/19/16	0	0	0	0	0	0	0	31230	27499	19	3	2
01/20/16	02/19/16	02/22/16	02/26/16	660	634	2	730	1	-70	-70	31890	28133	19	3	2
01/27/16	02/26/16	02/29/16	03/04/16	0	0	0	0	0	0	0	31890	28133	24	3	2.25
02/03/16	03/04/16	03/07/16	03/11/16	780	767	1	780	1	0	0	32670	28900	22	3.25	1.75
02/10/16	03/11/16	03/14/16	03/18/16	0	0	0	0	0	0	0	32670	28900	24	2	2.5
02/17/16	03/18/16	03/21/16	03/25/16	0	0	0	0	0	0	0	32670	28900	24	2	2.5
02/24/16	03/25/16	03/28/16	04/01/16	0	0	0	0	0	0	0	32670	28900	23	2	2
03/02/16	04/01/16	04/04/16	04/08/16	280	111	13	2230	7	-1040	-1610	32950	29011	3	0.25	1.5
03/09/16	04/08/16	04/11/16	04/15/16	(230)	(347)	9	1300	3	-480	-980	32720	28664	5	1.5	0.5
03/16/16	04/15/16	04/18/16	04/22/16	2670	2397	21	4890	7	-350	-1760	35390	31061	3	0.5	1.5
03/23/16	04/22/16	04/25/16	04/29/16	(650)	(728)	6	1190	2	-760	-1840	34740	30333	6	1.5	0.25
03/30/16	04/29/16	05/02/16	05/06/16	2700	2596	8	3850	5	-950	-1150	37440	32929	3	2	1
04/06/16	05/06/16	05/09/16	05/13/16	(310)	(375)	5	1430	2	-1350	-1350	37130	32554	8	2.5	1.25
04/13/16	05/13/16	05/16/16	05/20/16	(1370)	(1487)	9	570	3	-730	-1400	35760	31067	16	1	0.25
04/20/16	05/20/16	05/23/16	05/27/16	(1750)	(1854)	8	390	3	-550	-1870	34010	29213	11	0.75	1.25
04/27/16	05/27/16	05/30/16	06/03/16	(1720)	(1824)	8	1040	3	-700	-1720	32290	27389	3	1.25	1.5
05/04/16	06/03/16	06/06/16	06/10/16	(1980)	(2123)	11	450	2	-880	-1980	30310	25266	6	0.5	0.75
05/11/16	06/10/16	06/13/16	06/17/16	760	526	18	2290	7	-390	-820	31070	25792	9	0.25	0.5
05/18/16	06/17/16	06/20/16	06/24/16	1690	1586	8	2590	5	-470	-470	32760	27378	8	0.25	1.25
05/25/16	06/24/16	06/27/16	07/01/16	880	750	10	2670	5	-770	-1050	33640	28128	5	0.75	1.25
06/01/16	07/01/16	07/04/16	07/08/16	2000	1974	2	2000	2	0	0	35640	30102	22	0.75	2
06/08/16	07/08/16	07/11/16	07/15/16	990	847	11	2160	4	-420	-660	36630	30949	8	1	0.75
06/15/16	07/15/16	07/18/16	07/22/16	(440)	(531)	7	810	2	-490	-550	36190	30418	3	1	1.75
06/22/16	07/22/16	07/25/16	07/29/16	(880)	(1010)	10	1110	3	-680	-980	35310	29408	3	1	1.25
06/29/16	07/29/16	08/01/16	08/05/16	1310	1232	6	2270	4	-900	-900	36620	30640	3	1	2.25
07/06/16	08/05/16	08/08/16	08/12/16	(590)	(759)	13	1390	5	-370	-1050	36030	29881	12	0.25	0.5
07/13/16	08/12/16	08/15/16	08/19/16	0	0	0	0	0	0	0	36030	29881	9	2.25	2.25
07/20/16	08/19/16	08/22/16	08/26/16	(610)	(636)	2	0	0	-590	-610	35420	29245	9	2	2.25
07/27/16	08/26/16	08/29/16	09/02/16	1830	1752	6	1990	4	-130	-130	37250	30997	4	1	1.25
08/03/16	09/02/16	09/05/16	09/09/16	(940)	(1057)	9	1730	4	-1020	-1860	36310	29940	4	1	1.25
08/10/16	09/09/16	09/12/16	09/16/16	(2320)	(2502)	14	1190	5	-1070	-3320	33990	27438	6	0.5	1
08/17/16	09/16/16	09/19/16	09/23/16	1800	1670	10	2600	5	-360	-550	35790	29108	4	0.75	1.25
08/24/16	09/23/16	09/26/16	09/30/16	450	268	14	3020	5	-520	-1980	36240	29376	4	1	1.25
08/31/16	09/30/16	10/03/16	10/07/16	430	378	4	780	3	-350	-350	36670	29754	6	1	1.25
09/07/16	10/07/16	10/10/16	10/14/16	1190	1060	10	1710	6	-200	-240	37860	30814	6	1	0.5
09/14/16	10/14/16	10/17/16	10/21/16	(580)	(671)	7	800	4	-770	-920	37280	30143	3	1.75	0.5
09/21/16	10/21/16	10/24/16	10/28/16	(500)	(643)	11	1630	5	-900	-1480	36780	29500	9	0.75	0.25
09/28/16	10/28/16	10/31/16	11/04/16	(4100)	(4295)	15	270	3	-1290	-4110	32680	25205	6	0.25	1.25
10/05/16	11/04/16	11/07/16	11/11/16	310	115	15	1780	6	-300	-890	32990	25320	5	1	0.5

In-Sample Dates		Out-of-Sample Dates		osnp	NOnp$13	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
10/12/16	11/11/16	11/14/16	11/18/16	(330)	(421)	7	1230	4	-1090	-1500	32660	24899	3	1	2
10/19/16	11/18/16	11/21/16	11/25/16	440	427	1	440	1	0	0	33100	25326	24	1.5	1.5
10/26/16	11/25/16	11/28/16	12/02/16	(1300)	(1326)	2	110	1	-1410	-1410	31800	24000	4	3	1.75
11/02/16	12/02/16	12/05/16	12/09/16	250	172	6	920	3	-500	-500	32050	24172	4	0.75	2
11/09/16	12/09/16	12/12/16	12/16/16	(830)	(934)	8	1830	4	-1240	-2410	31220	23238	3	0.75	2
11/16/16	12/16/16	12/19/16	12/23/16	(30)	(121)	7	1450	3	-990	-1480	31190	23117	3	0.25	2
11/23/16	12/23/16	12/26/16	12/30/16	0	0	0	0	0	0	0	31190	23117	21	1.75	1
11/30/16	12/30/16	01/02/17	01/06/17	1370	1344	2	1850	1	-480	-480	32560	24461	17	1.75	1
12/07/16	01/06/17	01/09/17	01/13/17	2180	2102	6	2580	5	-400	-400	34740	26563	5	1.25	0.75
12/14/16	01/13/17	01/16/17	01/20/17	(1070)	(1096)	2	0	0	-830	-1070	33670	25467	14	1.25	2
12/21/16	01/20/17	01/23/17	01/27/17	(80)	(119)	3	140	1	-170	-220	33590	25348	16	0.5	1.25
12/28/16	01/27/17	01/30/17	02/03/17	(660)	(725)	5	420	3	-750	-1020	32930	24623	3	2.5	1.25
01/04/17	02/03/17	02/06/17	02/10/17	650	572	6	1160	3	-210	-510	33580	25195	3	1	1
01/11/17	02/10/17	02/13/17	02/17/17	(310)	(336)	2	210	1	-520	-520	33270	24859	21	1.75	0.75
01/18/17	02/17/17	02/20/17	02/24/17	(80)	(106)	2	20	1	-100	-100	33190	24753	18	2	0.75
01/25/17	02/24/17	02/27/17	03/03/17	(340)	(431)	7	760	4	-620	-650	32850	24322	6	1.25	0.25
02/01/17	03/03/17	03/06/17	03/10/17	430	404	2	1260	1	-830	-830	33280	24726	7	1.5	1.75
02/08/17	03/10/17	03/13/17	03/17/17	0	0	0	0	0	0	0	33280	24726	5	2	2.25
02/15/17	03/17/17	03/20/17	03/24/17	0	0	0	0	0	0	0	33280	24726	5	2	2.25
02/22/17	03/24/17	03/27/17	03/31/17	0	0	0	0	0	0	0	33280	24726	5	2	2.25
03/01/17	03/31/17	04/03/17	04/07/17	770	692	6	1220	4	-330	-330	34050	25418	3	0.5	1.5
03/08/17	04/07/17	04/10/17	04/14/17	(500)	(565)	5	280	2	-470	-650	33550	24853	24	0.25	0.5
03/15/17	04/14/17	04/17/17	04/21/17	(950)	(1158)	16	1910	5	-420	-1110	32600	23695	10	0.25	0.75
03/22/17	04/21/17	04/24/17	04/28/17	(280)	(293)	1	0	0	-280	-280	32320	23402	9	1.25	2.25
03/29/17	04/28/17	05/01/17	05/05/17	50	37	1	50	1	0	0	32370	23439	8	2.5	2
04/05/17	05/05/17	05/08/17	05/12/17	230	217	1	230	1	0	0	32600	23656	5	1.25	1.75
04/12/17	05/12/17	05/15/17	05/19/17	320	242	6	980	3	-320	-660	32920	23898	13	0.25	0.75
04/19/17	05/19/17	05/22/17	05/26/17	800	683	9	2230	3	-390	-1070	33720	24581	9	0.25	1
04/26/17	05/26/17	05/29/17	06/02/17	(600)	(665)	5	290	2	-640	-850	33120	23916	16	0.5	1.5
05/03/17	06/02/17	06/05/17	06/09/17	(320)	(463)	11	1080	3	-380	-1360	32800	23453	4	1	0.75
05/10/17	06/09/17	06/12/17	06/16/17	650	559	7	1640	2	-720	-940	33450	24012	11	0.75	0.25
05/17/17	06/16/17	06/19/17	06/23/17	490	360	10	1890	3	-390	-990	33940	24372	11	0.75	0.25
05/24/17	06/23/17	06/26/17	06/30/17	680	485	15	1720	7	-200	-830	34620	24857	11	0.25	0.25
05/31/17	06/30/17	07/03/17	07/07/17	(620)	(932)	24	2310	8	-530	-1430	34000	23925	10	0.25	0.25
06/07/17	07/07/17	07/10/17	07/14/17	0	0	0	0	0	0	0	34000	23925	24	1.5	1.5
06/14/17	07/14/17	07/17/17	07/21/17	0	0	0	0	0	0	0	34000	23925	21	1.5	1.75
06/21/17	07/21/17	07/24/17	07/28/17	0	0	0	0	0	0	0	34000	23925	24	1.5	1.5
06/28/17	07/28/17	07/31/17	08/04/17	(620)	(633)	1	0	0	-620	-620	33380	23292	24	1.25	1.5
07/05/17	08/04/17	08/07/17	08/11/17	(720)	(928)	16	1820	5	-620	-1330	32660	22364	12	0.25	0.5
07/12/17	08/11/17	08/14/17	08/18/17	2230	2087	11	3420	6	-440	-440	34890	24451	7	0.5	0.5
07/19/17	08/18/17	08/21/17	08/25/17	(510)	(692)	14	1530	5	-400	-710	34380	23759	7	0.5	0.5
07/26/17	08/25/17	08/28/17	09/01/17	1430	1326	8	2260	6	-500	-500	35810	25085	9	0.75	0.5
08/02/17	09/01/17	09/04/17	09/08/17	800	774	2	800	2	0	0	36610	25859	11	1.75	1.5
08/09/17	09/08/17	09/11/17	09/15/17	0	0	0	0	0	0	0	36610	25859	11	2.75	1.5
08/16/17	09/15/17	09/18/17	09/22/17	0	0	0	0	0	0	0	36610	25859	12	1.75	1.5
08/23/17	09/22/17	09/25/17	09/29/17	1350	1233	9	2400	6	-700	-740	37960	27092	4	0.25	1.25
08/30/17	09/29/17	10/02/17	10/06/17	(190)	(242)	4	390	3	-580	-580	37770	26850	7	1	1.25
09/06/17	10/06/17	10/09/17	10/13/17	530	504	2	530	2	0	0	38300	27354	5	1.25	2.25
09/13/17	10/13/17	10/16/17	10/20/17	0	(26)	2	230	1	-230	-230	38300	27328	5	1.25	2.5
09/20/17	10/20/17	10/23/17	10/27/17	710	671	3	1040	2	-330	-330	39010	27999	8	0.75	1.75
09/27/17	10/27/17	10/30/17	11/03/17	480	441	3	740	2	-260	-260	39490	28440	17	0.75	1
10/04/17	11/03/17	11/06/17	11/10/17	1990	1795	15	3170	7	-370	-790	41480	30235	8	0.25	0.5
10/11/17	11/10/17	11/13/17	11/17/17	(20)	(33)	1	0	0	-20	-20	41460	30202	22	1.5	1.25
10/18/17	11/17/17	11/20/17	11/24/17	0	0	0	0	0	0	0	41460	30202	19	1.5	1.75
10/25/17	11/24/17	11/27/17	12/01/17	(170)	(183)	1	0	0	-170	-170	41290	30019	19	1.5	1.75
11/01/17	12/01/17	12/04/17	12/08/17	0	0	0	0	0	0	0	41290	30019	17	1.5	2.25
11/08/17	12/08/17	12/11/17	12/15/17	30	(113)	11	2120	2	-490	-1600	41320	29906	7	1	0.25
11/15/17	12/15/17	12/18/17	12/22/17	240	201	3	380	2	-140	-140	41560	30107	3	1	1.25
11/22/17	12/22/17	12/25/17	12/29/17	60	21	3	610	1	-370	-550	41620	30128	7	1	0.75
11/29/17	12/29/17	01/01/18	01/05/18	(180)	(232)	4	560	1	-390	-740	41440	29896	12	0.5	1
12/06/17	01/05/18	01/08/18	01/12/18	1520	1442	6	2000	4	-270	-270	42960	31338	6	0.75	0.75

In-Sample Dates		Out-of-Sample Dates		osnp	NOnp$13	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
12/13/17	01/12/18	01/15/18	01/19/18	(960)	(1051)	7	70	1	-500	-1030	42000	30287	6	0.75	0.75
12/20/17	01/19/18	01/22/18	01/26/18	(1240)	(1305)	5	780	1	-900	-2020	40760	28982	3	2	1.5
12/27/17	01/26/18	01/29/18	02/02/18	380	250	10	990	7	-260	-470	41140	29232	21	0.25	0.5
01/03/18	02/02/18	02/05/18	02/09/18	(2510)	(2562)	4	450	1	-1540	-2510	38630	26670	24	1	2
01/10/18	02/09/18	02/12/18	02/16/18	960	947	1	960	1	0	0	39590	27617	12	2.5	2
01/17/18	02/16/18	02/19/18	02/23/18	0	(13)	1	0	0	0	0	39590	27604	12	2.5	2
01/24/18	02/23/18	02/26/18	03/02/18	660	647	1	660	1	0	0	40250	28251	12	2.5	2
01/31/18	03/02/18	03/05/18	03/09/18	(10)	(36)	2	300	1	-310	-310	40240	28215	13	2.25	2.5
02/07/18	03/09/18	03/12/18	03/16/18	(390)	(416)	2	60	1	-450	-450	39850	27799	13	2.25	2.5
02/14/18	03/16/18	03/19/18	03/23/18	1650	1559	7	2690	4	-730	-740	41500	29358	3	0.25	1.75
02/21/18	03/23/18	03/26/18	03/30/18	(1670)	(1865)	15	1210	5	-590	-1840	39830	27493	3	0.25	1.75
02/28/18	03/30/18	04/02/18	04/06/18	1430	1261	13	2930	6	-540	-790	41260	28754	7	0.25	1.25
03/07/18	04/06/18	04/09/18	04/13/18	(2090)	(2324)	18	890	6	-620	-2090	39170	26430	7	0.75	0.25
03/14/18	04/13/18	04/16/18	04/20/18	(1440)	(1700)	20	1660	5	-540	-2100	37730	24730	7	0.75	0.25
03/21/18	04/20/18	04/23/18	04/27/18	(280)	(371)	7	1190	3	-580	-1290	37450	24359	5	1	2
03/28/18	04/27/18	04/30/18	05/04/18	(40)	(53)	1	0	0	-40	-40	37410	24306	7	2	2.25
04/04/18	05/04/18	05/07/18	05/11/18	(600)	(626)	2	60	1	-660	-660	36810	23680	23	2	1.5
04/11/18	05/11/18	05/14/18	05/18/18	(190)	(216)	2	90	1	-280	-280	36620	23464	8	1.75	1.75
04/18/18	05/18/18	05/21/18	05/25/18	(500)	(513)	1	0	0	-500	-500	36120	22951	6	1.75	2.25
04/25/18	05/25/18	05/28/18	06/01/18	(610)	(636)	2	100	1	-710	-710	35510	22315	16	1	2.5
05/02/18	06/01/18	06/04/18	06/08/18	(140)	(179)	3	440	1	-440	-580	35370	22136	3	2.5	3.25
05/09/18	06/08/18	06/11/18	06/15/18	1120	1055	5	1630	3	-510	-510	36490	23191	11	0.75	1
05/16/18	06/15/18	06/18/18	06/22/18	1270	1127	11	2620	6	-470	-690	37760	24318	8	0.25	1.25
05/23/18	06/22/18	06/25/18	06/29/18	200	161	3	480	2	-280	-280	37960	24479	24	1.5	1.75
05/30/18	06/29/18	07/02/18	07/06/18	(980)	(1136)	12	2430	6	-1690	-2820	36980	23343	11	0.5	0.75
06/06/18	07/06/18	07/09/18	07/13/18	820	703	9	2470	2	-570	-1010	37800	24046	15	0.75	0.75
06/13/18	07/13/18	07/16/18	07/20/18	(160)	(173)	1	0	0	-160	-160	37640	23873	20	1.5	3
06/20/18	07/20/18	07/23/18	07/27/18	(1360)	(1412)	4	200	2	-1350	-1360	36280	22461	15	0.75	3
06/27/18	07/27/18	07/30/18	08/03/18	3030	2926	8	3120	7	-90	-90	39310	25387	4	1.25	0.5
07/04/18	08/03/18	08/06/18	08/10/18	0	0	0	0	0	0	0	39310	25387	24	2	3
07/11/18	08/10/18	08/13/18	08/17/18	1620	1412	16	3310	6	-410	-1250	40930	26799	4	1.25	0.5
07/18/18	08/17/18	08/20/18	08/24/18	(1090)	(1155)	5	0	0	-640	-1090	39840	25644	16	0.75	1.25
07/25/18	08/24/18	08/27/18	08/31/18	0	0	0	0	0	0	0	39840	25644	24	1.75	1
08/01/18	08/31/18	09/03/18	09/07/18	(80)	(210)	10	1650	5	-480	-910	39760	25434	9	1	0.5
08/08/18	09/07/18	09/10/18	09/14/18	(520)	(559)	3	690	1	-780	-1210	39240	24875	20	1.25	3.25
08/15/18	09/14/18	09/17/18	09/21/18	450	281	13	2060	7	-470	-820	39690	25156	13	0.5	0.25
08/22/18	09/21/18	09/24/18	09/28/18	1320	1164	12	2080	6	-180	-530	41010	26320	13	0.5	0.25
08/29/18	09/28/18	10/01/18	10/05/18	660	452	16	3610	6	-1070	-1540	41670	26772	5	1.5	0.75
09/05/18	10/05/18	10/08/18	10/12/18	0	0	0	0	0	0	0	41670	26772	22	2	3
09/12/18	10/12/18	10/15/18	10/19/18	1460	1343	9	2380	5	-440	-630	43130	28115	3	1.75	0.25
09/19/18	10/19/18	10/22/18	10/26/18	(360)	(607)	19	2630	6	-610	-1530	42770	27508	3	1.75	0.25
09/26/18	10/26/18	10/29/18	11/02/18	100	74	2	640	1	-540	-540	42870	27582	8	2.75	1.75
10/03/18	11/02/18	11/05/18	11/09/18	(910)	(1066)	12	1560	4	-450	-1290	41960	26516	17	0.25	0.75
10/10/18	11/09/18	11/12/18	11/16/18	4210	4106	8	5870	5	-730	-1290	46170	30622	14	1.25	0.25
10/17/18	11/16/18	11/19/18	11/23/18	(810)	(875)	5	1160	2	-1160	-1550	45360	29747	24	1.5	0.75
10/24/18	11/23/18	11/26/18	11/30/18	(2060)	(2086)	2	0	0	-1310	-2060	43300	27661	4	2.5	2.5
10/31/18	11/30/18	12/03/18	12/07/18	(850)	(915)	5	370	1	-780	-850	42450	26746	24	1.25	0.75
11/07/18	12/07/18	12/10/18	12/14/18	770	640	10	2850	5	-800	-1900	43220	27386	12	1.5	0.25
11/14/18	12/14/18	12/17/18	12/21/18	1190	1047	11	4340	4	-1100	-1800	44410	28433	7	1.5	0.5
11/21/18	12/21/18	12/24/18	12/28/18	4060	3995	5	4760	4	-700	-700	48470	32428	18	0.75	0.5
11/28/18	12/28/18	12/31/18	01/04/19	(120)	(133)	1	0	0	-120	-120	48350	32295	17	3	3
12/05/18	01/04/19	01/07/19	01/11/19	90	77	1	90	1	0	0	48440	32372	11	2.75	3.25
12/12/18	01/11/19	01/14/19	01/18/19	310	297	1	310	1	0	0	48750	32669	12	2.75	2.75
12/19/18	01/18/19	01/21/19	01/25/19	(1190)	(1281)	7	480	2	-550	-1430	47560	31388	3	2	0.5
12/26/18	01/25/19	01/28/19	02/01/19	3260	3156	8	3570	6	-170	-310	50820	34544	14	0.25	1
01/02/19	02/01/19	02/04/19	02/08/19	0	0	0	0	0	0	0	50820	34544	24	2.5	2.25
01/09/19	02/08/19	02/11/19	02/15/19	(1110)	(1201)	7	570	2	-660	-1110	49710	33343	10	1	0.75
01/16/19	02/15/19	02/18/19	02/22/19	(1850)	(1954)	8	420	3	-1380	-2180	47860	31389	7	1.25	0.25
01/23/19	02/22/19	02/25/19	03/01/19	(1560)	(1703)	11	750	4	-650	-1900	46300	29686	4	0.25	1.75
01/30/19	03/01/19	03/04/19	03/08/19	80	(102)	14	2180	6	-650	-1250	46380	29584	4	0.25	1.5
02/06/19	03/08/19	03/11/19	03/15/19	500	383	9	1360	5	-330	-690	46880	29967	4	0.5	1.5

In-Sample Dates		Out-of-Sample Dates		osnp	NOnp$13	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
02/13/19	03/15/19	03/18/19	03/22/19	480	389	7	1590	3	-590	-1050	47360	30356	5	0.5	1.5
02/20/19	03/22/19	03/25/19	03/29/19	(380)	(484)	8	1020	4	-700	-1250	46980	29872	22	0.75	0.25
02/27/19	03/29/19	04/01/19	04/05/19	1140	1036	8	2270	4	-520	-960	48120	30908	5	0.5	1.5
03/06/19	04/05/19	04/08/19	04/12/19	(150)	(293)	11	1350	5	-440	-1160	47970	30615	5	0.5	1.5
03/13/19	04/12/19	04/15/19	04/19/19	340	301	3	430	2	-90	-90	48310	30916	16	0.5	1.25
03/20/19	04/19/19	04/22/19	04/26/19	(850)	(889)	3	130	1	-930	-980	47460	30027	17	1	1.5
03/27/19	04/26/19	04/29/19	05/03/19	260	182	6	1180	3	-580	-630	47720	30209	3	1.75	2.25
04/03/19	05/03/19	05/06/19	05/10/19	(310)	(505)	15	1260	6	-330	-560	47410	29704	11	0.5	0.75
04/10/19	05/10/19	05/13/19	05/17/19	730	574	12	2460	3	-500	-870	48140	30278	11	0.75	0.25
04/17/19	05/17/19	05/20/19	05/24/19	2010	1880	10	3180	6	-620	-1070	50150	32158	11	0.5	1
04/24/19	05/24/19	05/27/19	05/31/19	1600	1457	11	4150	7	-940	-1120	51750	33615	8	0.25	1.25
05/01/19	05/31/19	06/03/19	06/07/19	(80)	(93)	1	0	0	-80	-80	51670	33522	22	2.75	2.5
05/08/19	06/07/19	06/10/19	06/14/19	0	0	0	0	0	0	0	51670	33522	18	3	2.5
05/15/19	06/14/19	06/17/19	06/21/19	540	514	2	960	1	-420	-420	52210	34036	3	2.75	3
05/22/19	06/21/19	06/24/19	06/28/19	0	0	0	0	0	0	0	52210	34036	17	1.5	3
05/29/19	06/28/19	07/01/19	07/05/19	100	87	1	100	1	0	0	52310	34123	15	2	3.25
06/05/19	07/05/19	07/08/19	07/12/19	0	0	0	0	0	0	0	52310	34123	10	2.25	2.25
06/12/19	07/12/19	07/15/19	07/19/19	5360	5269	7	5660	5	-170	-300	57670	39392	3	2	1
06/19/19	07/19/19	07/22/19	07/26/19	0	0	0	0	0	0	0	57670	39392	14	1.5	3
06/26/19	07/26/19	07/29/19	08/02/19	430	404	2	580	1	-150	-150	58100	39796	14	1.5	3.25
07/03/19	08/02/19	08/05/19	08/09/19	260	234	2	450	1	-190	-190	58360	40030	16	2.5	2
07/10/19	08/09/19	08/12/19	08/16/19	(20)	(59)	3	920	1	-810	-810	58340	39971	15	1.5	2
07/17/19	08/16/19	08/19/19	08/23/19	(940)	(1005)	5	1050	2	-1090	-1720	57400	38966	4	2	2.75
07/24/19	08/23/19	08/26/19	08/30/19	(60)	(73)	1	0	0	-60	-60	57340	38893	18	1.75	2.25
07/31/19	08/30/19	09/02/19	09/06/19	2490	2386	8	3070	5	-330	-440	59830	41279	15	0.5	0.75
08/07/19	09/06/19	09/09/19	09/13/19	(2000)	(2182)	14	2050	5	-920	-2430	57830	39097	17	0.25	0.5
08/14/19	09/13/19	09/16/19	09/20/19	(3410)	(3644)	18	2560	6	-1030	-4290	54420	35453	5	1.25	1.25
08/21/19	09/20/19	09/23/19	09/27/19	0	0	0	0	0	0	0	54420	35453	7	2.75	3.25
08/28/19	09/27/19	09/30/19	10/04/19	0	0	0	0	0	0	0	54420	35453	7	2	2.75
09/04/19	10/04/19	10/07/19	10/11/19	0	0	0	0	0	0	0	54420	35453	7	2	2.75
09/11/19	10/11/19	10/14/19	10/18/19	0	0	0	0	0	0	0	54420	35453	7	2	2.75
09/18/19	10/18/19	10/21/19	10/25/19	440	414	2	940	1	-500	-500	54860	35867	6	1.75	2.5
09/25/19	10/25/19	10/28/19	11/01/19	290	277	1	290	1	0	0	55150	36144	6	1.75	2.75
10/02/19	11/01/19	11/04/19	11/08/19	480	454	2	480	2	0	0	55630	36598	24	1.5	1.5
10/09/19	11/08/19	11/11/19	11/15/19	340	288	4	420	2	-80	-80	55970	36886	7	1	1.25
10/16/19	11/15/19	11/18/19	11/22/19	(140)	(231)	7	1490	2	-860	-1170	55830	36655	7	1	1.5
10/23/19	11/22/19	11/25/19	11/29/19	920	855	5	2050	2	-490	-940	56750	37510	19	1	0.25
10/30/19	11/29/19	12/02/19	12/06/19	450	164	22	2750	10	-300	-1340	57200	37674	6	0.5	0.75
11/06/19	12/06/19	12/09/19	12/13/19	(2620)	(2724)	8	230	2	-820	-2620	54580	34950	18	1	0.25
11/13/19	12/13/19	12/16/19	12/20/19	390	364	2	390	1	0	0	54970	35314	8	1.25	1
11/20/19	12/20/19	12/23/19	12/27/19	210	171	3	250	2	-40	-40	55180	35485	13	0.5	1.25
11/27/19	12/27/19	12/30/19	01/03/20	(1820)	(1989)	13	630	3	-620	-2130	53360	33496	10	0.5	0.5
12/04/19	01/03/20	01/06/20	01/10/20	(1810)	(1862)	4	750	2	-2150	-2150	51550	31634	7	1.25	2.75
12/11/19	01/10/20	01/13/20	01/17/20	110	58	4	530	1	-320	-420	51660	31692	5	1.25	1
12/18/19	01/17/20	01/20/20	01/24/20	(170)	(300)	10	960	4	-550	-660	51490	31392	11	0.5	1
12/25/19	01/24/20	01/27/20	01/31/20	(580)	(723)	11	890	6	-610	-1300	50910	30669	10	0.5	1.25
01/01/20	01/31/20	02/03/20	02/07/20	0	0	0	0	0	0	0	50910	30669	5	2.25	2.75
01/08/20	02/07/20	02/10/20	02/14/20	450	359	7	780	4	-200	-210	51360	31028	14	0.75	0.25
01/15/20	02/14/20	02/17/20	02/21/20	(1950)	(2106)	12	590	4	-780	-2130	49410	28922	14	0.75	0.25
01/23/20	02/22/20	02/25/20	02/29/20	2280	2111	13	3990	6	-820	-1150	51690	31033	14	0.75	0.25
01/29/20	02/28/20	03/02/20	03/06/20	1420	1368	4	2560	3	-1140	-1140	53110	32401	4	2.5	2.5
02/05/20	03/06/20	03/09/20	03/13/20	1170	1066	8	4340	3	-1250	-1580	54280	33467	8	2	2.25
02/12/20	03/13/20	03/16/20	03/20/20	3100	3009	7	5940	4	-2080	-2300	57380	36476	14	1.75	2.25
02/19/20	03/20/20	03/23/20	03/27/20	550	485	5	1210	3	-510	-510	57930	36961	3	2	2.75
02/26/20	03/27/20	03/30/20	04/03/20	8140	8010	10	8420	7	-120	-280	66070	44971	3	1.75	3
03/04/20	04/03/20	04/06/20	04/10/20	(720)	(876)	12	4300	6	-1180	-1980	65350	44095	3	1.75	3
03/11/20	04/10/20	04/13/20	04/17/20	0	0	0	0	0	0	0	65350	44095	6	3.5	3
03/18/20	04/17/20	04/20/20	04/24/20	(1210)	(1444)	18	6100	7	-1380	-3230	64140	42651	4	3.25	3.25
03/25/20	04/24/20	04/27/20	05/01/20	1760	1630	10	2830	6	-430	-740	65900	44281	3	1.75	3.5
04/01/20	05/01/20	05/04/20	05/08/20	(1720)	(1824)	8	1700	5	-3010	-3240	64180	42457	3	1.5	3.5
04/08/20	05/08/20	05/11/20	05/15/20	0	0	0	0	0	0	0	64180	42457	23	3.5	2

In-Sample Dates		Out-of-Sample Dates		osnp	NOnp$13	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
04/15/20	05/15/20	05/18/20	05/22/20	0	0	0	0	0	0	0	64180	42457	23	3.5	2
04/22/20	05/22/20	05/25/20	05/29/20	3590	3460	10	4080	8	-410	-410	67770	45917	19	0.25	0.5
04/29/20	05/29/20	06/01/20	06/05/20	0	0	0	0	0	0	0	67770	45917	21	2	2.25
05/06/20	06/05/20	06/08/20	06/12/20	(1210)	(1457)	19	3290	5	-920	-3080	66560	44460	3	1	2
05/13/20	06/12/20	06/15/20	06/19/20	780	676	8	2830	4	-1060	-1530	67340	45136	10	1	2.25
05/20/20	06/19/20	06/22/20	06/26/20	1910	1754	12	3660	7	-600	-900	69250	46890	5	1.25	1
05/27/20	06/26/20	06/29/20	07/03/20	920	829	7	1050	6	-130	-130	70170	47719	6	1.25	1.25
06/03/20	07/03/20	07/06/20	07/10/20	1060	1034	2	1060	2	0	0	71230	48753	3	2	2
06/10/20	07/10/20	07/13/20	07/17/20	410	358	4	900	2	-380	-380	71640	49111	10	1	1
06/17/20	07/17/20	07/20/20	07/24/20	210	145	5	920	2	-520	-600	71850	49256	3	0.25	2.75
06/24/20	07/24/20	07/27/20	07/31/20	980	928	4	1160	3	-180	-180	72830	50184	6	1.25	1.25
07/01/20	07/31/20	08/03/20	08/07/20	(640)	(809)	13	2230	3	-730	-2580	72190	49375	3	0.5	1.25
07/08/20	08/07/20	08/10/20	08/14/20	0	0	0	0	0	0	0	72190	49375	7	1.5	3
07/15/20	08/14/20	08/17/20	08/21/20	940	914	2	940	2	0	0	73130	50289	6	1.5	2.5
07/22/20	08/21/20	08/24/20	08/28/20	(850)	(967)	9	440	4	-450	-870	72280	49322	4	0.5	1.5
07/29/20	08/28/20	08/31/20	09/04/20	290	277	1	290	1	0	0	72570	49599	7	2	2.25
08/05/20	09/04/20	09/07/20	09/11/20	690	534	12	2130	7	-630	-1310	73260	50133	7	1	0.75
08/12/20	09/11/20	09/14/20	09/18/20	1640	1393	19	2880	7	-380	-540	74900	51526	4	0.5	1
08/19/20	09/18/20	09/21/20	09/25/20	(1090)	(1220)	10	1110	4	-580	-2040	73810	50306	14	0.5	1
08/26/20	09/25/20	09/28/20	10/02/20	300	287	1	300	1	0	0	74110	50593	8	2.5	2.25
09/02/20	10/02/20	10/05/20	10/09/20	0	0	0	0	0	0	0	74110	50593	8	2.5	2.75
09/09/20	10/09/20	10/12/20	10/16/20	0	0	0	0	0	0	0	74110	50593	8	2	2.75
09/16/20	10/16/20	10/19/20	10/23/20	0	0	0	0	0	0	0	74110	50593	24	1.5	2.5
09/23/20	10/23/20	10/26/20	10/30/20	(380)	(419)	3	430	2	-810	-810	73730	50174	23	0.75	1
09/30/20	10/30/20	11/02/20	11/06/20	430	404	2	630	1	-200	-200	74160	50578	21	1.75	1.25
10/07/20	11/06/20	11/09/20	11/13/20	(220)	(246)	2	390	1	-610	-610	73940	50332	3	2.25	3
10/14/20	11/13/20	11/16/20	11/20/20	0	0	0	0	0	0	0	73940	50332	5	1.75	2
10/21/20	11/20/20	11/23/20	11/27/20	690	612	6	1330	4	-490	-640	74630	50944	3	1	1.25
10/28/20	11/27/20	11/30/20	12/04/20	(1270)	(1452)	14	1030	5	-740	-1270	73360	49492	3	1	1.25
11/04/20	12/04/20	12/07/20	12/11/20	40	(142)	14	1550	6	-730	-1070	73400	49350	17	0.25	0.25
11/11/20	12/11/20	12/14/20	12/18/20	1670	1566	8	2240	6	-470	-570	75070	50916	3	0.5	1.75
11/18/20	12/18/20	12/21/20	12/25/20	1260	1195	5	1810	3	-340	-340	76330	52111	3	0.75	1.75
11/25/20	12/25/20	12/28/20	01/01/21	150	33	9	1070	3	-320	-760	76480	52144	9	0.5	0.75
12/02/20	01/01/21	01/04/21	01/08/21	1670	1566	8	2720	6	-910	-1050	78150	53710	4	0.5	1.75
12/09/20	01/08/21	01/11/21	01/15/21	(60)	(73)	1	0	0	-60	-60	78090	53637	4	1.5	2.75
12/16/20	01/15/21	01/18/21	01/22/21	(1000)	(1117)	9	460	1	-420	-1460	77090	52520	4	1	1.25
12/23/20	01/22/21	01/25/21	01/29/21	10	(3)	1	10	1	0	0	77100	52517	6	2	3
12/30/20	01/29/21	02/01/21	02/05/21	(1120)	(1133)	1	0	0	-1120	-1120	75980	51384	5	2	2.25
01/06/21	02/05/21	02/08/21	02/12/21	1150	1098	4	1490	3	-340	-340	77130	52482	6	1	2.25
01/13/21	02/12/21	02/15/21	02/19/21	(1860)	(1990)	10	1240	3	-900	-2610	75270	50492	6	0.75	1.5
01/20/21	02/19/21	02/22/21	02/26/21	(3540)	(4008)	36	2560	12	-790	-5390	71730	46484	4	1	0.75
01/27/21	02/26/21	03/01/21	03/05/21	1430	1404	2	1430	2	0	0	73160	47888	8	2	3.5
02/03/21	03/05/21	03/08/21	03/12/21	(840)	(1035)	15	2070	5	-550	-2370	72320	46853	3	1	1.75
02/10/21	03/12/21	03/15/21	03/19/21	2700	2674	2	2700	2	0	0	75020	49527	22	2	2.25
02/17/21	03/19/21	03/22/21	03/26/21	230	191	3	1010	1	-510	-510	75250	49718	7	2.75	3.5
02/24/21	03/26/21	03/29/21	04/02/21	420	199	17	3940	7	-960	-2850	75670	49917	4	1	1.75
03/03/21	04/02/21	04/05/21	04/09/21	4250	4107	11	5560	7	-540	-710	79920	54024	4	1.5	1.75
03/10/21	04/09/21	04/12/21	04/16/21	1020	981	3	1960	2	-940	-940	80940	55005	5	1.25	2
03/17/21	04/16/21	04/19/21	04/23/21	(520)	(650)	10	1080	5	-530	-990	80420	54355	5	1.25	1.75
03/24/21	04/23/21	04/26/21	04/30/21	0	0	0	0	0	0	0	80420	54355	7	2	2.75
03/31/21	04/30/21	05/03/21	05/07/21	(1050)	(1076)	2	0	0	-570	-1050	79370	53279	7	2	2
04/07/21	05/07/21	05/10/21	05/14/21	(870)	(896)	2	0	0	-520	-870	78500	52383	24	2	1.25
04/14/21	05/14/21	05/17/21	05/21/21	390	234	12	3550	7	-1360	-2220	78890	52617	8	0.25	1.25
04/21/21	05/21/21	05/24/21	05/28/21	0	0	0	0	0	0	0	78890	52617	11	2	3.25
04/28/21	05/28/21	05/31/21	06/04/21	(80)	(93)	1	0	0	-80	-80	78810	52524	12	1.75	2.5
05/05/21	06/04/21	06/07/21	06/11/21	0	0	0	0	0	0	0	78810	52524	11	2	3.25
05/12/21	06/11/21	06/14/21	06/18/21	3120	2886	18	5350	9	-650	-1040	81930	55410	3	1.5	0.25
05/19/21	06/18/21	06/21/21	06/25/21	70	(112)	14	1760	8	-480	-1330	82000	55298	14	0.25	0.5
05/26/21	06/25/21	06/28/21	07/02/21	(2160)	(2394)	18	800	6	-570	-2400	79840	52904	19	0.25	0.25
06/02/21	07/02/21	07/05/21	07/09/21	(620)	(711)	7	1510	2	-760	-1370	79220	52193	18	1.5	0.25
06/09/21	07/09/21	07/12/21	07/16/21	(1820)	(1872)	4	160	1	-1260	-1980	77400	50321	4	2.25	3.25

In-Sample Dates		Out-of-Sample Dates		osnp	NOnp$13	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
06/16/21	07/16/21	07/19/21	07/23/21	1860	1834	2	1860	2	0	0	79260	52155	8	2.25	3
06/23/21	07/23/21	07/26/21	07/30/21	(970)	(1009)	3	0	0	-500	-970	78290	51146	5	1.75	1.5
06/30/21	07/30/21	08/02/21	08/06/21	510	354	12	2680	5	-510	-1450	78800	51500	5	1.75	1.75
07/07/21	08/06/21	08/09/21	08/13/21	1630	1539	7	2490	3	-700	-700	80430	53039	4	0.5	2.75
07/14/21	08/13/21	08/16/21	08/20/21	(4020)	(4306)	22	2460	5	-930	-5150	76410	48733	4	0.5	1.75
07/21/21	08/20/21	08/23/21	08/27/21	1370	1253	9	2130	5	-360	-650	77780	49986	5	1	2
07/28/21	08/27/21	08/30/21	09/03/21	(120)	(159)	3	580	2	-700	-700	77660	49827	5	1.5	2
08/04/21	09/03/21	09/06/21	09/10/21	(1530)	(1712)	14	480	5	-510	-1610	76130	48115	3	1	2
08/11/21	09/10/21	09/13/21	09/17/21	(800)	(930)	10	980	4	-530	-1180	75330	47185	15	0.25	1
08/18/21	09/17/21	09/20/21	09/24/21	(2330)	(2499)	13	1370	4	-930	-3370	73000	44686	3	1.75	0.25
08/25/21	09/24/21	09/27/21	10/01/21	(430)	(456)	2	0	0	-280	-430	72570	44230	7	3.5	2.75
09/01/21	10/01/21	10/04/21	10/08/21	970	944	2	970	2	0	0	73540	45174	16	2.5	2
09/08/21	10/08/21	10/11/21	10/15/21	0	0	0	0	0	0	0	73540	45174	16	3.5	2
09/15/21	10/15/21	10/18/21	10/22/21	(870)	(883)	1	0	0	-870	-870	72670	44291	16	3.5	2
09/22/21	10/22/21	10/25/21	10/29/21	(1390)	(1559)	13	3160	4	-1330	-2600	71280	42732	10	0.75	1.75
09/29/21	10/29/21	11/01/21	11/05/21	1900	1718	14	5030	6	-1400	-1400	73180	44450	8	1.5	0.25
10/06/21	11/05/21	11/08/21	11/12/21	0	0	0	0	0	0	0	73180	44450	24	3	3
10/13/21	11/12/21	11/15/21	11/19/21	0	0	0	0	0	0	0	73180	44450	24	3	3
10/20/21	11/19/21	11/22/21	11/26/21	4260	4234	2	4260	2	0	0	77440	48684	24	3	3
10/27/21	11/26/21	11/29/21	12/03/21	7600	7353	19	11740	10	-930	-1450	85040	56037	8	0.25	1.25
11/03/21	12/03/21	12/06/21	12/10/21	850	694	12	3440	4	-800	-1780	85890	56731	8	0.25	1.5
11/10/21	12/10/21	12/13/21	12/17/21	0	0	0	0	0	0	0	85890	56731	19	2.75	3
11/17/21	12/17/21	12/20/21	12/24/21	4890	4812	6	5190	5	-300	-300	90780	61543	4	0.5	2.25
11/24/21	12/24/21	12/27/21	12/31/21	4900	4770	10	5270	7	-220	-370	95680	66313	4	0.5	2.25
12/01/21	12/31/21	01/03/22	01/07/22	(2840)	(3113)	21	1940	7	-1000	-3810	92840	63200	5	1.25	1
12/08/21	01/07/22	01/10/22	01/14/22	50	(93)	11	2510	4	-1010	-1010	92890	63107	9	1.5	0.75
12/15/21	01/14/22	01/17/22	01/21/22	(1200)	(1499)	23	2250	9	-480	-1330	91690	61608	8	0.75	0.25
12/22/21	01/21/22	01/24/22	01/28/22	2100	2022	6	3630	3	-870	-870	93790	63630	18	1.5	0.75
12/29/21	01/28/22	01/31/22	02/04/22	(360)	(386)	2	0	0	-320	-360	93430	63244	24	2.75	2
01/05/22	02/04/22	02/07/22	02/11/22	(130)	(143)	1	0	0	-130	-130	93300	63101	24	3	2.75
01/12/22	02/11/22	02/14/22	02/18/22	(360)	(386)	2	540	1	-900	-900	92940	62715	24	3	2.75
01/19/22	02/18/22	02/21/22	02/25/22	2260	2195	5	4960	2	-1700	-2700	95200	64910	22	3.25	2.75
01/26/22	02/25/22	02/28/22	03/04/22	8970	8567	31	20930	14	-1410	-2850	104170	73477	5	2.25	1.5
02/02/22	03/04/22	03/07/22	03/11/22	13240	12941	23	26410	12	-3540	-4240	117410	86418	7	3.25	2.25
02/09/22	03/11/22	03/14/22	03/18/22	(3880)	(4036)	12	4870	4	-1980	-6740	113530	82382	10	2.75	3
02/16/22	03/18/22	03/21/22	03/25/22	(6640)	(6848)	16	3540	4	-2130	-8200	106890	75534	10	3.5	1.5
02/23/22	03/25/22	03/28/22	04/01/22	1340	1106	18	8800	9	-1730	-2760	108230	76640	9	2.5	2
03/02/22	04/01/22	04/04/22	04/08/22	860	587	21	9720	10	-1420	-2440	109090	77227	7	2	2.25
03/09/22	04/08/22	04/11/22	04/15/22	3610	3493	9	6500	3	-1170	-1450	112700	80720	20	0.5	0.75
03/16/22	04/15/22	04/18/22	04/22/22	650	455	15	6900	7	-1280	-3570	113350	81175	7	2	2.25
03/23/22	04/22/22	04/25/22	04/29/22	(350)	(467)	9	4750	4	-1990	-3840	113000	80708	17	2.75	0.5
03/30/22	04/29/22	05/02/22	05/06/22	3960	3817	11	7340	6	-1270	-1450	116960	84525	18	1.75	0.5
04/06/22	05/06/22	05/09/22	05/13/22	5020	4903	9	7650	6	-1040	-1300	121980	89428	14	2.5	1.25
04/13/22	05/13/22	05/16/22	05/20/22	4390	4286	8	6980	4	-1140	-1720	126370	93714	17	2.5	0.5
04/20/22	05/20/22	05/23/22	05/27/22	1080	1067	1	1080	1	0	0	127450	94781	19	3	2.75
04/27/22	05/27/22	05/30/22	06/03/22	1170	1131	3	1550	2	-380	-380	128620	95912	17	2.75	3.5
05/04/22	06/03/22	06/06/22	06/10/22	4740	4519	17	7690	7	-640	-1570	133360	100431	11	1	0.5
05/11/22	06/10/22	06/13/22	06/17/22	8660	8335	25	17050	12	-1220	-1940	142020	108766	7	1.75	1.25
05/18/22	06/17/22	06/20/22	06/24/22	(710)	(762)	4	1890	1	-2010	-2270	141310	108004	17	3.5	3.5
05/25/22	06/24/22	06/27/22	07/01/22	7730	7574	12	9480	7	-830	-1160	149040	115578	5	3.5	2.75
06/01/22	07/01/22	07/04/22	07/08/22	9320	9190	10	11910	7	-1430	-1740	158360	124768	5	3.5	3.5
06/08/22	07/08/22	07/11/22	07/15/22	3340	3184	12	7600	6	-1320	-2150	161700	127952	17	0.5	2
06/15/22	07/15/22	07/18/22	07/22/22	3330	3252	6	4800	4	-840	-1470	165030	131204	17	0.5	2.25
06/22/22	07/22/22	07/25/22	07/29/22	2700	2583	9	6640	5	-2270	-3130	167730	133787	15	2.5	0.75
06/29/22	07/29/22	08/01/22	08/05/22	2720	2564	12	6670	7	-2200	-2370	170450	136351	19	0.25	1.75
07/06/22	08/05/22	08/08/22	08/12/22	3300	3196	8	6690	4	-1940	-2920	173750	139547	6	1.5	3.25
07/13/22	08/12/22	08/15/22	08/19/22	(1520)	(1624)	8	3640	3	-1430	-4470	172230	137923	15	3	0.75
07/20/22	08/19/22	08/22/22	08/26/22	(3340)	(3587)	19	8990	7	-1940	-10170	168890	134336	6	1.5	3
07/27/22	08/26/22	08/29/22	09/02/22	7850	7759	7	8440	6	-590	-590	176740	142095	22	1.5	0.5
08/03/22	09/02/22	09/05/22	09/09/22	30	(61)	7	3020	4	-1100	-2990	176770	142034	13	2	2.5
08/10/22	09/09/22	09/12/22	09/16/22	960	817	11	2820	7	-560	-790	177730	142851	15	1.5	1

In-Sample Dates		Out-of-Sample Dates		osnp	NOnp$13	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
08/17/22	09/16/22	09/19/22	09/23/22	(1360)	(1490)	10	4080	5	-1920	-4260	176370	141361	15	1.5	1
08/24/22	09/23/22	09/26/22	09/30/22	(910)	(1040)	10	4300	4	-2320	-4620	175460	140321	10	2.75	0.75
08/31/22	09/30/22	10/03/22	10/07/22	(200)	(291)	7	2170	3	-1430	-2290	175260	140030	11	2.25	1.75
09/07/22	10/07/22	10/10/22	10/14/22	5540	5475	5	5560	4	-20	-20	180800	145505	7	3.5	1.25
09/14/22	10/14/22	10/17/22	10/21/22	(1080)	(1236)	12	4970	5	-2310	-3690	179720	144269	5	3.25	0.25
09/21/22	10/21/22	10/24/22	10/28/22	50	(106)	12	2950	6	-1320	-2410	179770	144163	6	2.5	0.25
09/28/22	10/28/22	10/31/22	11/04/22	(3080)	(3171)	7	730	2	-1860	-3080	176690	140992	5	3.5	1.25
10/05/22	11/04/22	11/07/22	11/11/22	1120	912	16	4920	5	-690	-2600	177810	141904	3	3	0.75
10/12/22	11/11/22	11/14/22	11/18/22	350	116	18	7040	8	-1680	-2420	178160	142020	3	2.75	1.5
10/19/22	11/18/22	11/21/22	11/25/22	7220	7116	8	8800	5	-930	-1250	185380	149136	11	1.25	1.5
10/26/22	11/25/22	11/28/22	12/02/22	1130	974	12	4430	8	-2530	-2800	186510	150110	7	2.25	0.25
11/02/22	12/02/22	12/05/22	12/09/22	12220	12077	11	13910	7	-770	-770	198730	162187	7	2.25	0.25
11/09/22	12/09/22	12/12/22	12/16/22	(820)	(1054)	18	4270	9	-1270	-2240	197910	161133	8	2	0.5
11/16/22	12/16/22	12/19/22	12/23/22	(3300)	(3417)	9	1370	2	-1690	-3300	194610	157716	9	0.5	2
11/23/22	12/23/22	12/26/22	12/30/22	(770)	(874)	8	2360	3	-1390	-1660	193840	156842	7	1.5	1.75
11/30/22	12/30/22	01/02/23	01/06/23	(3980)	(4123)	11	1580	4	-1310	-5240	189860	152719	24	0.5	0.5
12/07/22	01/06/23	01/09/23	01/13/23	(1390)	(1481)	7	1470	2	-1480	-2630	188470	151238	20	1.5	0.25
12/14/22	01/13/23	01/16/23	01/20/23	(710)	(801)	7	2570	3	-1380	-2930	187760	150437	20	1.75	0.25
12/21/22	01/20/23	01/23/23	01/27/23	750	659	7	3460	4	-1380	-2710	188510	151096	8	2.5	1.75
12/28/22	01/27/23	01/30/23	02/03/23	4420	4290	10	7680	5	-1020	-1940	192930	155386	8	2.75	1.5
01/04/23	02/03/23	02/06/23	02/10/23	1530	1361	13	3690	8	-780	-780	194460	156747	18	0.25	0.25
01/11/23	02/10/23	02/13/23	02/17/23	(2480)	(2675)	15	1080	3	-560	-3160	191980	154072	11	1.25	0.75
01/18/23	02/17/23	02/20/23	02/24/23	(2040)	(2157)	9	2210	4	-2250	-3820	189940	151915	6	0.25	2.5
01/25/23	02/24/23	02/27/23	03/03/23	(330)	(434)	8	3300	3	-870	-2800	189610	151481	15	0.5	2.25
02/01/23	03/03/23	03/06/23	03/10/23	220	12	16	5280	4	-900	-3040	189830	151493	7	1.25	1
02/08/23	03/10/23	03/13/23	03/17/23	950	781	13	5300	6	-1350	-1860	190780	152274	11	0.5	2
02/15/23	03/17/23	03/20/23	03/24/23	3130	3065	5	4370	4	-1240	-1240	193910	155339	11	0.25	2
02/22/23	03/24/23	03/27/23	03/31/23	1460	1330	10	3640	5	-800	-2160	195370	156669	4	0.25	2.5
03/01/23	03/31/23	04/03/23	04/07/23	(420)	(498)	6	660	4	-920	-1080	194950	156171	11	1	1.5
03/08/23	04/07/23	04/10/23	04/14/23	(1880)	(2153)	21	2200	9	-650	-2390	193070	154018	8	0.75	0.5
03/15/23	04/14/23	04/17/23	04/21/23	(2260)	(2390)	10	540	3	-760	-2750	190810	151628	4	1.75	2.25
03/22/23	04/21/23	04/24/23	04/28/23	1040	858	14	5420	4	-1020	-3500	191850	152486	4	2.25	1.5
03/29/23	04/28/23	05/01/23	05/05/23	(450)	(723)	21	4920	8	-1010	-2580	191400	151763	4	0.75	2.25
04/05/23	05/05/23	05/08/23	05/12/23	1670	1579	7	3050	4	-1100	-1320	193070	153342	5	2.5	0.5
04/12/23	05/12/23	05/15/23	05/19/23	1120	1016	8	2500	6	-1000	-1000	194190	154358	5	2.5	0.5
04/19/23	05/19/23	05/22/23	05/26/23	320	229	7	1770	2	-670	-1230	194510	154587	6	2.25	0.25
04/26/23	05/26/23	05/29/23	06/02/23	2310	2180	10	4160	5	-680	-1010	196820	156767	6	2.25	0.25
05/03/23	06/02/23	06/05/23	06/09/23	2130	2026	8	3450	6	-930	-1320	198950	158793	14	1.5	0.5
05/10/23	06/09/23	06/12/23	06/16/23	1580	1450	10	3080	6	-910	-910	200530	160243	8	0.75	1.25
05/17/23	06/16/23	06/19/23	06/23/23	1860	1704	12	3720	7	-660	-1030	202390	161947	8	0.75	1.25
05/24/23	06/23/23	06/26/23	06/30/23	(1530)	(1595)	5	1010	1	-1560	-2020	200860	160352	4	2.75	3
05/31/23	06/30/23	07/03/23	07/07/23	2010	1841	13	4490	5	-860	-1900	202870	162193	11	0.25	0.75
06/07/23	07/07/23	07/10/23	07/14/23	(430)	(534)	8	2170	2	-1070	-1070	202440	161659	4	1.5	2.25
06/14/23	07/14/23	07/17/23	07/21/23	(450)	(580)	10	2740	4	-960	-2630	201990	161079	4	1.25	2.25
06/21/23	07/21/23	07/24/23	07/28/23	(470)	(652)	14	2440	6	-660	-2720	201520	160427	3	1.5	1.75
06/28/23	07/28/23	07/31/23	08/04/23	2880	2815	5	3380	4	-500	-500	204400	163242	10	1.25	2
07/05/23	08/04/23	08/07/23	08/11/23	(1490)	(1698)	16	3170	3	-840	-1780	202910	161544	6	1.25	1.25
07/12/23	08/11/23	08/14/23	08/18/23	590	538	4	960	2	-330	-370	203500	162082	11	1.75	2.25
07/19/23	08/18/23	08/21/23	08/25/23	(180)	(310)	10	3150	4	-1400	-1740	203320	161772	4	0.25	2.25
07/26/23	08/25/23	08/28/23	09/01/23	0	0	0	0	0	0	0	203320	161772	18	2.5	3
08/02/23	09/01/23	09/04/23	09/08/23	(570)	(583)	1	0	0	-570	-570	202750	161189	18	2.5	2.75
08/09/23	09/08/23	09/11/23	09/15/23	(1550)	(1693)	11	970	2	-660	-2190	201200	159496	12	1	0.75
08/16/23	09/15/23	09/18/23	09/22/23	810	706	8	2350	4	-630	-1070	202010	160202	7	2	2.25
08/23/23	09/22/23	09/25/23	09/29/23	(150)	(215)	5	930	2	-920	-920	201860	159987	7	2	2
08/30/23	09/29/23	10/02/23	10/06/23	470	236	18	5340	8	-870	-2680	202330	160223	15	0.5	0.5
09/06/23	10/06/23	10/09/23	10/13/23	80	(37)	9	2710	4	-1320	-1320	202410	160186	9	2.25	0.75
09/13/23	10/13/23	10/16/23	10/20/23	(2340)	(2405)	5	540	1	-950	-2880	200070	157781	7	1.75	2
09/20/23	10/20/23	10/23/23	10/27/23	3690	3573	9	5210	5	-600	-1520	203760	161354	6	1.75	2
09/27/23	10/27/23	10/30/23	11/03/23	0	0	0	0	0	0	0	203760	161354	16	3	3.5
10/04/23	11/03/23	11/06/23	11/10/23	0	0	0	0	0	0	0	203760	161354	21	2.5	2.5
10/11/23	11/10/23	11/13/23	11/17/23	4350	4285	5	4840	4	-490	-490	208110	165639	3	3	1.75

In-Sample Dates		Out-of-Sample Dates		osnp	NOnp$13	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
10/18/23	11/17/23	11/20/23	11/24/23	1180	1167	1	1180	1	0	0	209290	166806	12	2.75	2.25
10/25/23	11/24/23	11/27/23	12/01/23	4100	3970	10	5980	6	-760	-1310	213390	170776	5	2.25	2
11/01/23	12/01/23	12/04/23	12/08/23	(880)	(919)	3	1350	1	-1300	-2230	212510	169857	18	2.25	1.75
11/08/23	12/08/23	12/11/23	12/15/23	350	324	2	630	1	-280	-280	212860	170181	16	3	1.5
11/15/23	12/15/23	12/18/23	12/22/23	(170)	(183)	1	0	0	-170	-170	212690	169998	18	2.5	1.75
11/22/23	12/22/23	12/25/23	12/29/23	1680	1563	9	3370	5	-610	-1120	214370	171561	20	0.5	0.25
11/29/23	12/29/23	01/01/24	01/05/24	2430	2274	12	3850	7	-540	-890	216800	173835	13	1.25	0.25
12/06/23	01/05/24	01/08/24	01/12/24	200	(86)	22	3530	10	-740	-1060	217000	173749	3	1.25	2
12/13/23	01/12/24	01/15/24	01/19/24	2150	1968	14	3690	8	-490	-630	219150	175717	3	1.25	2
12/20/23	01/19/24	01/22/24	01/26/24	(540)	(566)	2	0	0	-420	-540	218610	175151	24	1.75	3.25
12/27/23	01/26/24	01/29/24	02/02/24	0	0	0	0	0	0	0	218610	175151	24	2.75	3.5
01/03/24	02/02/24	02/05/24	02/09/24	(1130)	(1312)	14	1560	6	-1060	-1680	217480	173839	6	1.75	0.25
01/10/24	02/09/24	02/12/24	02/16/24	(2390)	(2572)	14	2080	5	-1410	-2670	215090	171267	6	1.75	0.25
01/17/24	02/16/24	02/19/24	02/23/24	0	0	0	0	0	0	0	215090	171267	8	2.5	2.25
01/24/24	02/23/24	02/26/24	03/01/24	1370	1292	6	1630	4	-230	-260	216460	172559	5	2	1.5
01/31/24	03/01/24	03/04/24	03/08/24	(3980)	(4123)	11	860	3	-1500	-4020	212480	168436	3	1.5	2.25
02/07/24	03/08/24	03/11/24	03/15/24	0	0	0	0	0	0	0	212480	168436	6	3.25	2.5
02/14/24	03/15/24	03/18/24	03/22/24	0	0	0	0	0	0	0	212480	168436	6	3.25	2.5
02/21/24	03/22/24	03/25/24	03/29/24	0	0	0	0	0	0	0	212480	168436	6	2.5	2.5
02/28/24	03/29/24	04/01/24	04/05/24	130	117	1	130	1	0	0	212610	168553	6	2.5	2.5
03/06/24	04/05/24	04/08/24	04/12/24	1760	1565	15	3960	10	-730	-1320	214370	170118	10	1	0.25
03/13/24	04/12/24	04/15/24	04/19/24	210	197	1	210	1	0	0	214580	170315	18	2	2.75
03/20/24	04/19/24	04/22/24	04/26/24	1770	1627	11	3060	6	-480	-670	216350	171942	11	1	0.25
03/27/24	04/26/24	04/29/24	05/03/24	900	705	15	3250	6	-530	-1230	217250	172647	11	1	0.25
04/03/24	05/03/24	05/06/24	05/10/24	0	0	0	0	0	0	0	217250	172647	18	2	3.25
04/10/24	05/10/24	05/13/24	05/17/24	(480)	(584)	8	1260	4	-570	-1190	216770	172063	21	1	0.25
04/17/24	05/17/24	05/20/24	05/24/24	(1390)	(1533)	11	1610	3	-690	-2390	215380	170530	22	1	0.25
04/24/24	05/24/24	05/27/24	05/31/24	(30)	(121)	7	2170	3	-1050	-1050	215350	170409	10	1.25	0.75
05/01/24	05/31/24	06/03/24	06/07/24	960	921	3	1120	2	-160	-160	216310	171330	4	2.75	2.5
05/08/24	06/07/24	06/10/24	06/14/24	1720	1538	14	3790	6	-640	-640	218030	172868	3	0.25	1.75
05/15/24	06/14/24	06/17/24	06/21/24	0	0	0	0	0	0	0	218030	172868	20	2	2.75
05/22/24	06/21/24	06/24/24	06/28/24	0	0	0	0	0	0	0	218030	172868	20	2	2.75
05/29/24	06/28/24	07/01/24	07/05/24	550	537	1	550	1	0	0	218580	173405	20	2	2.75
06/05/24	07/05/24	07/08/24	07/12/24	560	521	3	630	2	-70	-70	219140	173926	9	1.5	2.5
06/12/24	07/12/24	07/15/24	07/19/24	0	0	0	0	0	0	0	219140	173926	4	2.25	2.75
06/19/24	07/19/24	07/22/24	07/26/24	660	621	3	1530	1	-860	-860	219800	174547	4	2.25	2.75
06/26/24	07/26/24	07/29/24	08/02/24	4060	3930	10	5150	6	-460	-850	223860	178477	6	1.5	0.5
07/03/24	08/02/24	08/05/24	08/09/24	(1630)	(1851)	17	2010	6	-770	-2080	222230	176626	6	1.5	0.5
07/10/24	08/09/24	08/12/24	08/16/24	1090	986	8	2780	4	-670	-1480	223320	177612	9	0.75	1.75
07/17/24	08/16/24	08/19/24	08/23/24	(450)	(580)	10	2680	5	-1080	-2600	222870	177032	9	0.5	1.75
07/24/24	08/23/24	08/26/24	08/30/24	(1190)	(1281)	7	160	2	-580	-1320	221680	175751	9	0.75	1.75
07/31/24	08/30/24	09/02/24	09/06/24	2460	2421	3	2460	3	0	0	224140	178172	12	3	2
08/07/24	09/06/24	09/09/24	09/13/24	(2530)	(2647)	9	1770	4	-1990	-3340	221610	175525	21	1	1
08/14/24	09/13/24	09/16/24	09/20/24	(620)	(646)	2	0	0	-310	-620	220990	174879	3	2.5	2.25
08/21/24	09/20/24	09/23/24	09/27/24	(1930)	(2073)	11	960	4	-840	-2290	219060	172806	23	0.25	0.5
08/28/24	09/27/24	09/30/24	10/04/24	2140	2049	7	4330	4	-1290	-1290	221200	174855	15	0.75	1.25
09/04/24	10/04/24	10/07/24	10/11/24	2530	2413	9	4340	4	-510	-1180	223730	177268	15	0.75	1.25
09/11/24	10/11/24	10/14/24	10/18/24	0	0	0	0	0	0	0	223730	177268	9	3.25	3.5
09/18/24	10/18/24	10/21/24	10/25/24	0	0	0	0	0	0	0	223730	177268	9	3.25	3.5
09/25/24	10/25/24	10/28/24	11/01/24	0	0	0	0	0	0	0	223730	177268	9	3.25	3.5
10/02/24	11/01/24	11/04/24	11/08/24	(310)	(336)	2	340	1	-650	-650	223420	176932	5	2.75	3.5
10/09/24	11/08/24	11/11/24	11/15/24	(2130)	(2286)	12	1100	4	-820	-2130	221290	174646	3	0.25	2.25
10/16/24	11/15/24	11/18/24	11/22/24	1470	1379	7	2850	4	-950	-1380	222760	176025	7	1	1.25
10/23/24	11/22/24	11/25/24	11/29/24	(3800)	(3969)	13	1280	3	-1280	-4570	218960	172056	9	0.25	1.5
10/30/24	11/29/24	12/02/24	12/06/24	1060	995	5	1880	3	-770	-820	220020	173051	10	1.25	1.25
11/06/24	12/06/24	12/09/24	12/13/24	1100	1035	5	1230	4	-130	-130	221120	174086	7	1	1.25
11/13/24	12/13/24	12/16/24	12/20/24	0	0	0	0	0	0	0	221120	174086	4	2.5	2.25
11/20/24	12/20/24	12/23/24	12/27/24	0	0	0	0	0	0	0	221120	174086	4	2.5	2.25
11/27/24	12/27/24	12/30/24	01/03/25	240	227	1	240	1	0	0	221360	174313	4	2	1.75
12/04/24	01/03/25	01/06/25	01/10/25	340	275	5	1170	3	-430	-700	221700	174588	4	3	1.75
12/11/24	01/10/25	01/13/25	01/17/25	90	(14)	8	2320	4	-710	-1130	221790	174574	10	1	1.5

In-Sample Dates		Out-of-Sample Dates		osnp	NOnp$13	ont	ownp	ownt	ollt	odd	EQ	NetEq	N	vup	vdn
12/18/24	01/17/25	01/20/25	01/24/25	100	87	1	100	1	0	0	221890	174661	5	2.25	3
12/25/24	01/24/25	01/27/25	01/31/25	(90)	(116)	2	70	1	-160	-160	221800	174545	5	2.25	3
01/01/25	01/31/25	02/03/25	02/07/25	510	484	2	510	2	0	0	222310	175029	8	2.75	3.5
01/08/25	02/07/25	02/10/25	02/14/25	290	225	5	1540	3	-850	-850	222600	175254	4	2.5	0.25
01/15/25	02/14/25	02/17/25	02/21/25	0	0	0	0	0	0	0	222600	175254	8	2	3
01/22/25	02/21/25	02/24/25	02/28/25	0	0	0	0	0	0	0	222600	175254	14	2	3.25
01/29/25	02/28/25	03/03/25	03/07/25	4780	4650	10	5330	9	-550	-550	227380	179904	7	1.25	0.75
02/05/25	03/07/25	03/10/25	03/14/25	0	0	0	0	0	0	0	227380	179904	24	1.5	2
02/12/25	03/14/25	03/17/25	03/21/25	150	137	1	150	1	0	0	227530	180041	24	1.5	2
02/19/25	03/21/25	03/24/25	03/28/25	0	0	0	0	0	0	0	227530	180041	22	1.75	2.25
02/26/25	03/28/25	03/31/25	04/04/25	2190	1995	15	3560	7	-370	-960	229720	182036	14	0.25	0.25
03/05/25	04/04/25	04/07/25	04/11/25	2610	2285	25	8950	8	-730	-2760	232330	184321	8	0.5	1
03/12/25	04/11/25	04/14/25	04/18/25	310	297	1	310	1	0	0	232640	184618	18	1.75	3
03/19/25	04/18/25	04/21/25	04/25/25	0	0	0	0	0	0	0	232640	184618	18	2	3
03/26/25	04/25/25	04/28/25	05/02/25	610	584	2	610	2	0	0	233250	185202	18	2	3
04/02/25	05/02/25	05/05/25	05/09/25	(820)	(872)	4	270	1	-520	-820	232430	184330	12	1.5	1.5
04/09/25	05/09/25	05/12/25	05/16/25	0	0	0	0	0	0	0	232430	184330	11	2.25	3.25
04/16/25	05/16/25	05/19/25	05/23/25	(290)	(303)	1	0	0	-290	-290	232140	184027	11	2.25	3
04/23/25	05/23/25	05/26/25	05/30/25	70	57	1	70	1	0	0	232210	184084	24	2.5	1.5

Appendix: The *Normalization Multiplier*

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

Below is a table, generated by the #iRMedVtMULTSTD indicator of the standard deviation(SD) of the 712815 calculated RMedV values for different **N**. We used 5 min bars of the CL from 1/1/2013 to 5/26/23 to generate this table.

CL5M010113-052623 5 min bars Date Range 1130101 to 1230526
Total Number of Bars=736241 sqrt(N)Norm=0
Trading Times Constraint Start Time=0 EndTime=0

RMedV Multiplier to Scale RMedV N Range to One Std
2 Std=0.0 1/Std=0.0
3 Std=0.065024 1/Std=15.378960
4 Std=0.055546 1/Std=18.003075
5 Std=0.047342 1/Std=21.122911
6 Std=0.042738 1/Std=23.398412
7 Std=0.038771 1/Std=25.792282
8 Std=0.036130 1/Std=27.677799
9 Std=0.033673 1/Std=29.697591
10 Std=0.031903 1/Std=31.344970
11 Std=0.030213 1/Std=33.097821
12 Std=0.028895 1/Std=34.607575
13 Std=0.027620 1/Std=36.205743
14 Std=0.026593 1/Std=37.603751
15 Std=0.025612 1/Std=39.044376
16 Std=0.024809 1/Std=40.307442
17 Std=0.024003 1/Std=41.661430
18 Std=0.023349 1/Std=42.828140
19 Std=0.022674 1/Std=44.102415
20 Std=0.022103 1/Std=45.242740

1/Std Mult Ave=32.617635
As one can see the RMedV Standard Deviation for N=4 is 2.5 times the SD for N=20. This makes it difficult to find a range for vup and vdn that satisfy all N. We would like to find a multiplier of the RMedV that normalizes all the RMedV standard deviations for any given N to the same SDs.

Fortunately, the SDs for the different Ns for The RMedV are proportional to √**N**. So, if we multiply the RMedV by the √N, the RMedV for different N should have the same SDs and ranges. Below are the results for multiplying the RMedV by √N and computing it's standard deviation.

RMedV Multiplier to Scale RMedV N Range to One Std
2 Std=0.0 1/Std=0.0
3 Std=0.114441 1/Std=8.738099
4 Std=0.112604 1/Std=8.880718
5 Std=0.107389 1/Std=9.311984
6 Std=0.106082 1/Std=9.426695
7 Std=0.103985 1/Std=9.616792
8 Std=0.103547 1/Std=9.657454
9 Std=0.102365 1/Std=9.768961
10 Std=0.102245 1/Std=9.780442
11 Std=0.101559 1/Std=9.846492
12 Std=0.101442 1/Std=9.857818
13 Std=0.100930 1/Std=9.907816
14 Std=0.100853 1/Std=9.915461
15 Std=0.100549 1/Std=9.945427
16 Std=0.100603 1/Std=9.940072
17 Std=0.100329 1/Std=9.967254
18 Std=0.100422 1/Std=9.957990
19 Std=0.100210 1/Std=9.979009
20 Std=0.100223 1/Std=9.977714

1/Std Mult Ave=9.693120

As we can see the SDs are now very close. If we multiply all RMedVs by 9.69*√N then the SDs of the velocities for all will be normalized to 1. For this case 9.69 would be the multiplier ***xmult***, in the strategy and indicator. This allows us to do an optimization search for ranges of vup and vdn from 0.25 to 3.5 standard deviations for all N.

Please note that different futures and different time bars give different multipliers.