Trading DIA ETF 5min Bars Using the End Point Fast Fourier Transform Algorithm
Walk Forward in-sample 20 Trading weekdays and out-of-sample 1 Trading weekday

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 the working paper entitled "The Discrete Fourier Transform Illusion" ", www.meyersanalytics.com/publications2/dft.pdf, we demonstrated the misuses of the mathematical technique called the Fourier Transform as applied to the S&P500 index. There we showed how fitting the Fourier Transform to the S&P500 index data series produced a perfect curve fit on past data giving the illusion that this technique would predict the major turning points of the S&P500 index. Why does this happen? When the FFT went to fit the data, it already knew where all the tops and bottoms were. The FFT mathematics minimizes the error between the curve it generates and the real data points. This error minimization process forces the generated curve to smoothly fit the past data like a glove. As a matter of fact, it's almost impossible not to get an excellent fit. However, as we demonstrated, when we examined the Fourier Transform on a day-by-day walk forward basis this seemingly wondrous predictive capability disappeared.

Here it will be shown how to use EPFFT technique on a walk forward basis to trade 5-minute bars of the Dow Jones ETF (**DIA**).

The End Point FFT

In order to avoid the past data curve fit illusion, we will create an indicator that walks forward one bar at a time. This indicator will calculate the noise filtered FFT curve but only save the last point, or end point, of the curve on the day that it is calculated. We will then connect all the generated end points to produce a curve that matches what we would have seen if we performed the noise filtered FFT on the end point dates.

EPFFT Construction Details

Unfortunately constructing the noise filtered FFT of a price data series is not quite as simple as just taking 512 closing prices, and directly plugging them into a FFT algorithm.

The mathematics of the Discrete Fourier Transform(DFT) assumes that the time-domain sample is periodic and that it has captured an integral number of periods. This means that the DFT assumes the end of the sampled series implicitly wraps around to the beginning to start all over again. Thus for 512 sampled data points the DFT assumes that these 512 sampled data points repeat every 512 samples. With real data series this is seldom the case, and this creates what is called a wraparound effect in the frequency domain. The wraparound effect creates a lot of distortion on the ends of the price series when the noise filtered FFT is transformed back. Unfortunately, the end point of the price series is the very point we wish to estimate. While we can do nothing about the wrap around violation, we can significantly lessen it's effects by what is called zero padding.

The DFT assumes the time domain sample is periodic and repeats. Suppose a price series starts at 400 and wiggles and wags for 512 data samples ending at the value of 600. The DFT assumes that the price series starts at zero, suddenly jumps to 400, goes to 600 and suddenly jumps down to zero again and then repeats. The DFT must create all kinds of different frequencies in the frequency domain to try and match this type of behavior. These false frequencies created to match the jumps and the high average price completely swamp the amplitudes of any real frequencies making them look like noise. Fortunately, this effect can be almost eliminated by a simple technique called end point flattening.

The calculation of end point flattening coefficients is simple. If x(1) represents the first price in the sampled data series, x(n) represents the last point in the data series and y(i) equal to the new endpoint flattened series then:

$$a = x(1) \quad b=(x(n)-x(1))/(n-1)$$

$$y(i) = x(i) – [a+ b*(i-1)] \quad \text{for i=1 to n} \quad (1)$$

We can see that when i=1 then y(1)=0 and when i=n then y(n) =0. What we've done is subtract the beginning value of the time series to make the first value equal to zero and then rotate the rest of the time series such that the end point is now zero. This technique reduces the endpoint distortion but introduces a low frequency artifact into the Fourier Frequency spectrum.

EPFFT Curve Construction
For this article a sliding time-bar window of ***nsamp*** (this is an input to be determined by optimization) 5-min bars of DIA from 12/1/19 to 7/9/21 will be used.

Step 1 End flatten these nsamp DIA ETF prices using equation (1) above.

Step 2 Take the FFT of these nsamp points to create nsamp frequency domain complex numbers $\mathbf{f}_i$.

Step 3 Use a Low Pass Threshold filter that zeros out the frequencies whose magnitudes are less than **thres*Fmax**. **Thres** is the decimal percentage of **Fmax** and **Fmax** is the maximum frequency amplitude of the spectrum.

Step 4 Do an inverse FFT on the noise filtered spectrum and save the last 2 points. Although it's not obvious yet, we will need the noise filtered point one sample before the endpoint.

Reverse the end point flattening of **Step 1**

Step 5 Save the filtered end point and the point before. Call the endpoint **ep(k)** and the point before **ep1(k)** where **k** is the order of the sliding window. That is, the first sliding window k=1, the second, k=2, etc. Slide the nsamp bar data window forward one bar, and repeat steps 1 through 4.

When the data window is moved forward one bar at a time a new data sample is added to the end and the data sample at the beginning is subtracted. This adding and subtracting causes the end point flattening coefficients and the power in the frequency spectrum to jump around creating distortion and jitter in the calculation of the noise filtered end point. This random jumping of the FFT endpoints as the data window slides forward in time adds a random jump to FFT end point curve. Fortunately, this jumping can be minimized by creating a new end point curve from the two saved noise filtered end points, ep(k) and **ep1(k)**, above in step 5. Since turning points are of interest rather than magnitude then in **step 5** a new variable will be created called **sumEP** where

sumEP(k) = sumEP(k-1) + ep(k)-ep1(k)

This new curve **sumEP(k)** is the sum of all the changes in the individual ep(k)'s from their noise filtered FFT value one sample before. This change series minimizes the magnitude jump problem creating a fairly smooth **EPFFT** curve.

The EPFFT System Defined
Even though **sumEP** is a fairly smooth curve it still has a number of short-term wiggles preventing us from simply going long when the curve turns up and going short when the curve turns down. To create a system, we will use a simple curve following technique on DIA 5-minute bars.

Buy Rule:

- **IF sumEP** has moved up by more than the point amount of ***pntup*** from the lowest low recorded in **sumEP** while short then buy the **DIA** at the market.

Sell Rule:

- **IF sumEP** has moved down by more than the point amount ***pntdn*** from the highest high recorded in **sumEP** while long then sell the **DIA** at the market.

Intraday Bars Exit Rule:

Close the position at 1555 ET (no trades will be carried overnight).

Testing The EPFFT System Using Walk Forward Optimization

There will be four strategy parameters to determine:

1. ***thres***, Threshold filter.
2. ***pntup***, if **sumEP** has moved up by more than the point amount of ***pntup*** from the lowest low recorded in **sumEP** while short then issue a buy signal
3. ***pntdn***, **if sumEP** has moved down by more than the point amount ***pntdn*** from the highest high recorded in **sumEP** while long then sell
4. ***nsamp,*** sliding number of 5-min bars window of DIA to calculate the EPFFT SumEP at each bar.

As mentioned, to test this Strategy we will use five-minute bar prices of the Dow Jones ETF traded on the NYSE and known by the symbol DIA for the 399 trading days from December 9, 2019, to July 9, 2021.

We will test the EPFFT strategy with the above DIA 5 min bars on a ***walk forward basis***, where the **in-sample (IS)** will be **20 trading weekdays** and the **out-of-sample (OOS)** will be the **next trading weekday** following as will be described below. The days are weekdays only. Weekdays where the OOS falls on an exchange holiday or partial days are eliminated. Holidays that fall on a weekday create a 19-day IS. All other ***IS*** periods consist of 20 trading weekdays.

What Is a Walk Forward Optimization with In-Sample Section and Out-Of-Sample Sections?

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

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

Walk forward analysis attempts to minimize the curve fitting of price noise by using the law of averages from the Central Limit Theorem on the out-of-sample performance. In walk forward analysis the data is broken up into many in-sample and out-of-sample sections. Usually for any strategy, one has some performance metric selection procedure, which we will call a ***filter,*** used to select the strategy input parameters from the optimization run. For

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

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

To gain confidence that our input parameter selection method or filter, using the optimization output of the in-sample data, will produce profits, we must test the input parameters we found in the in-sample section on out-of-sample data. In addition, we must perform the in-sample/out-of-sample analysis many times. Why not just do the out-of-sample analysis once or just 10 times? Well just as in Poker or any card game, where there is considerable variation in luck from hand to hand, walk forward out-of-sample analysis give considerable variation in 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 EPFFT Strategy Parameters Using Walk Forward Optimization
There are four strategy parameters to find, **thres, *pntup, pntdn, nsamp.***

For the test data we will run the TS or MC optimization engine on **DIA** 5 min price bars from 12/9/2019 to 7/9/2021 with the following optimization ranges for the EPFFT strategy inputs. This will create **399, 20 weekday in-sample periods each followed by a 1 day out-of-sample period** (See Figure 1 for the in-sample/out-of-sample periods). The days are weekdays only. Weekdays where the OOS falls on an exchange holiday or partial days are eliminated. Holidays that fall on a weekday create a 19-day ***IS***. All other ***IS*** periods consist of 20 trading weekdays. The optimization ranges are:

1. **thres= from 5 to 15 in steps of 5**
2. **pntup from 0.5 to 5 steps of 0.5**
3. **pntdn from 0.5 to 5 in steps of 0..5**
4. **nsamp from 128 to 1024 in steps of 128**

The above thres, pntup, pntdn, nsamp will produce 2400 different input combinations or cases of the strategy input parameters for each of the 399 in-sample/out-of-sample files for the 19 months of 5 min bar DIA data.

Finding the Best Set of Strategy Inputs to use with an in-sample Metric Filter.

The PWFO generates a number of performance metrics in the in-sample section. (Please see https://meyersanalytics.com/Walk-Forward-Optimization for a listing of these performance metrics).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 a given set of strategy inputs in the ***in-sample*** section will produce statistically valid profits in the sum of all out-of-sample sections. In other words, we wish to find the best set of strategy inputs ***with a metric filter applied*** in each **in-sample** section that gives the "best" total out-of-sample results over all out-of-sample sections. This means if we applied our ***metric filter*** to the strategy inputs chosen in the in-sample section, we would ***only trade using those set of strategy inputs*** in the next out-of-sample section if the in-sample ***metric filter*** satisfied our criteria. ***Else no trades would be made*** in the next out-of-sample section.

The Walk Forward Strategy – Strategy Inputs with Metric Filters Explorer.
We wish to find ***one*** set of strategy inputs that we can trade in every out-of-sample section, but we will only trade that set of strategy inputs in the out-of-sample section if and only if they satisfy our in-sample ***metric-filter***. Else we will not trade the next out-of-sample section. In this paper the in-sample section is 20 trading days, and the out-of-sample section is the next trading day. After running the PWFO on the in-sample data, we examine the in-sample metric filter that we chose. If the strategy inputs we selected satisfy the in-sample metric filter requirements then we use those strategy inputs to trade the next day. If the strategy inputs do not satisfy the in-sample metric filter we do not trade the next day.

Let us define the in-sample ***metric-filter*** we will use here: in-sample (IS) Profit Factor (**PF≤ x**) and/or IS Losers in a row (**lr ≤ y)**, and/or IS equity curve straight line correlation coefficient t(**r^2(R2) ≤z)**. That is **PF ≤ x and/or lr≤ y and/or R2 ≤ z.**

What we are going to do here is look at every combination in the in-sample section of each **strategy input** with **PF ≤ x and/or lr<y and/or R2 ≤ z**. This will produce seven **strategy input|metric-filter** combinations:

1. **strategy input|PF ≤ x, lr≤y, R2 ≤ z|**
2. **strategy input|PF ≤ x, lr ≤ y|**
3. **strategy input|PF ≤ x, R2 ≤ z|**
4. **strategy input|PF ≤ x |**
5. **strategy input|LR ≤ y, R2 ≤ z|**
6. **strategy input|lr ≤ x|**
7. **strategy input|R2 ≤ z|**
8. **strategy input – we also examine inputs with no filter**

If the **strategy input|metric-filter** satisfies **the metric-filte**r condition in the in-sample section, then we will use those strategy inputs to trade in the out-of-sample section. If not, then there will be no trades in the out-of-sample section.

We will look at all **IS metric-filter** combinations of **PF≤2 to 6 step 1, LR≤3,5 step 2 and R2≤40 to 80 step 5.** We will also look at the strategy input with no metric-filter. With 2400 different strategy input combinations this will give us 432000 **strategy input|metric-filter** combinations. Each one of these 432000-strategy **input|metric-filter** combinations will be applied to each in-sample section and their out-of-sample performance will be tabulated for all 399 PWFO files.

Below is a snippet of the output from a run of all 432000 combinations sorted by **tONP = total OOS net profit for each strategy input|metric-filter** combination. ***The column definitions are defined in Figure 3 below***. This example shows a partial output file from the WFINP program run on the PWFO files generated with the EPFFT that was run on 100 shares of DIA ETF 5-minute bars 399 days from 12/9/2019 to 7/9/2021. The in-sample (IS) period is 20 trading weekdays, and the out-of-sample (OOS) period is the next trading weekday. This strategy traded between 9am to 1600pm Exchange Time (EST).

From this run, we chose the filter on row 3 of the Figure below. That is,

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5|1.5|5|128|0|1555|2.9|pf≤2|lr≤5. This is constructed as follows. For the strategy inputs **5|1.5|5|128|0|1555|2.9|**only those in-sample sections that have a **pf ≤2** and **lr2≤5** are used to trade in the following out-of-sample sections. If the in-sample pf > 2 and or lr>5 then the out-of-sample section following the in-sample section ***is not*** traded.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA
1	DIA5mEPFFT20x1d	s12/31/19	e07/09/21	#399	AnyTnp						lSnt2			a(3.8)	s9.6	f431999					c=$4						
2	thr|pup|pdn|nsamp|xop|xt|<PF<LR<R2	toGP	tONP	aoGP	aoTr	ao#T	std	skew	kur	t	oW|oL	%Wtr	%P	LLtr	LLp	eqDD	wpr	lpr	#	V20	Dev^2	KTau	eqR2	Blw	BE	tkr|bl	Prob
3	5|1.5|5|128|0|1555|pf<2|lr<5	14801	13673	109	52.5	2.1	303	0.602	6.96	4.19	1.4	59	66	-983	-1040	-1040	7	4	136	16	1720	95	87	32	96	1134	5.00E-17
4	5|1.5|5|128|0|1555|pf<2|	14577	13317	97	46.3	2.1	314	0.43	6.34	3.79	1.38	57	65	-983	-1040	-1259	7	4	150	16	1677	94	87	32	117	836	1.11E-16
5	5|1.5|5|128|0|1555|pf<3|lr<5	14104	12812	88	43.7	2	311	0.356	6.51	3.58	1.33	57	63	-983	-1040	-1040	8	4	160	6	1733	92	86	53	131	411	5.00E-17
6	5|1.5|5|128|0|1555|pf<3|	14047	12615	80	39.2	2	318	0.262	6.07	3.34	1.33	55	62	-983	-1040	-1259	8	4	175	6	1721	92	86	53	151	331	1.67E-15
7	15|3.5|2|896|0|1555|lr<3	12299	11375	64	53.2	1.2	199	1.761	8.44	4.47	1.72	59	61	-322	-431	-841	12	4	191	-3	1991	69	77	86	84	329	2.50E-11
8	5|1.5|5|128|0|1555|pf<2|lr<5r2<80	12150	11206	100	51.5	1.9	285	0.765	8.57	3.86	1.4	59	66	-983	-1040	-1040	7	4	122	16	1134	95	92	32	113	936	3.33E-16
9	15|3.5|3.5|896|0|1555|	11916	11060	61	55.7	1.1	225	0.987	7.01	3.79	1.5	59	60	-526	-749	-1004	11	4	196	-2	1979	81	76	90	117	221	2.10E-10
10	15|3.5|3.5|896|0|1555|lr<5	11916	11060	61	55.7	1.1	225	0.987	7.01	3.79	1.5	59	60	-526	-749	-1004	11	4	196	-2	1979	81	76	90	117	221	2.10E-10
11	5|1.5|5|128|0|1555|pf<2|r2<80	11926	10850	88	44.3	2	299	0.509	7.44	3.42	1.37	57	65	-983	-1040	-1259	7	4	136	16	1102	94	92	32	143	644	3.33E-16
12	15|3.5|2|896|0|1555|lr<5	11594	10554	54	44.6	1.2	210	1.259	7.58	3.77	1.4	59	60	-603	-526	-1732	12	7	215	-1	1763	74	79	86	118	216	2.07E-08
13	15|3.5|2|896|0|1555|	11594	10554	54	44.6	1.2	210	1.259	7.58	3.77	1.4	59	60	-603	-526	-1732	12	7	215	-1	1763	74	79	86	118	216	2.07E-08
14	15|3.5|3|896|0|1555|lr<5	11324	10436	56	51	1.1	218	1.055	6.17	3.66	1.49	58	58	-526	-539	-986	11	5	201	2	1753	82	77	90	125	204	3.76E-09
15	15|3.5|3|896|0|1555|	11324	10436	56	51	1.1	218	1.055	6.17	3.66	1.49	58	58	-526	-539	-986	11	5	201	2	1753	82	77	90	125	204	3.76E-09

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 **(OSNP)** by chance. Here is 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 an In-Sample 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 random filters will choose a random row's OSNP of their own in each of the 500 files. At the end, each of the 5000 mirror filters will have 500 ***random*** OSNP's picked from the rows of the 500 files. The sum of the 500 random OSNP picks for each mirror filter will generate a random total out-of-sample net profit (toNP) or final random equity. The average and standard deviation of the 5000-mirror filter's different random toNPs will allow us to calculate the chance probability of our chosen filter's toNP. Thus, given the mirror filter's bootstrap random toNP average and standard deviation, we can calculate the probability of obtaining our chosen filter's toNP by pure chance alone. Figure 3 lists the 5000-mirror filter's bootstrap average for our 399 out-of-sample files of **-$3.8** with a bootstrap standard deviation of **$9.6**. (Side Note. The average is the average per out-of-sample period. So, the average for the random selection would be the average random toNP/399 and the average for the filter would be the filter toNP/# of OOS periods traded or 13673/136=100.5). The probability of obtaining our filters average daily net profit of **100.5** is $\mathbf{5x10^{-17}}$ which is **10.81** standard deviations from the bootstrap average. For our filter, in row 3 above, the expected number of cases that we could obtain by pure chance that would match or exceed **$100.5** is $[1-(1-\mathbf{5x10^{-17}})^{432000}]$ ~= $\mathbf{432000*5x10^{-17}}$ = $2.2x\ 10^{-11}$ where **432000** is the total number of different filters we looked at in this run. This number is much much less than one, so it is improbable that our result was due to pure chance.

Results

Figure 1 presents a graph of the equity curve generated by using the filter on the 399 days from 12/9/19 to 7/9/21. 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 DIA Daily Closing prices superimposed on the Equity Chart.

Figure 2 presents a plot of the EPFFT Strategy buy/sells and the EPFFT Indicator on the DIA 5min bars for 6/18/2021 - 6/24/2021.

Table 1 below presents a table of the 399 in-sample and out-of-sample windows, the **Filter** selected in-sample strategy inputs and the daily out-of-sample profit/loss results using the filter described above.

Discussion of Strategy Performance

In Figure 3, Row 3 of the spreadsheet filter output are some statistics that are of interest for our filter. An interesting statistic is **Blw**. **Blw** is the maximum number of days the equity curve failed to make a new high. **Blw** is **32** days for this filter. This means that 32 weekday trading days or 6 weeks was the longest time that the equity for this strategy failed to make a new equity high. **%Wtr** is the percentage of all OOS trades that were wins or positive. For this filter, the **%Wtr=59%**. **%P** is the % winning oos days, **%P=66%**. The average oos winning trade to the average oos losing trade ratio(**oW|oL**) was **1.4**. **wpr=7** is the maximum number of consecutive winning oos periods(days) in a row and **lpr=4** is the maximum number of consecutive losing oos periods(days) in a row. The Largest losing trade in the whole period was ($983) and the largest losing day was ($1040).

In Figure 1, which presents a graph of the equity curve using the filter on the 399 trading days of out-of-sample data, notice how the equity curve follows the 2nd order polynomial trend line with an R^2 of 0.961. The R^2 only dropped to 0.963 for the net equity curve.

Using this filter, the strategy was able to generate $13673 net equity after commissions of $0 (many brokers today 8/1/21 don't charge commissions) and slippage of $4 trading 100 DIA ETF shares for 399 days. The period of time from 2/20/20 to 4/30/20 was a volatile down then up market, yet the EPFFT strategy was able to adapt quite well.

In observing Table 1 we can see that this strategy and filter made trades from a low of no trades/day to a high of 7 trades/day with an average of 1.7 trades/day on the days it traded. For the no trade days, the strategy **input|filte**r in the in-sample section didn't satisfy the metric filter and no trades were made the next trading day. The **input|filter** traded **136** days out of the **399** days or about 34% of the time so there were many days in-a-row where no trades were made.

References

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Figure 1 Graph of EPFFT Strategy Out-Of-Sample Equity Applying the Walk Forward Filter Each Day on the in-sample section on DIA 5min Bar Prices 12/9/2019 to 7/9/2020

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

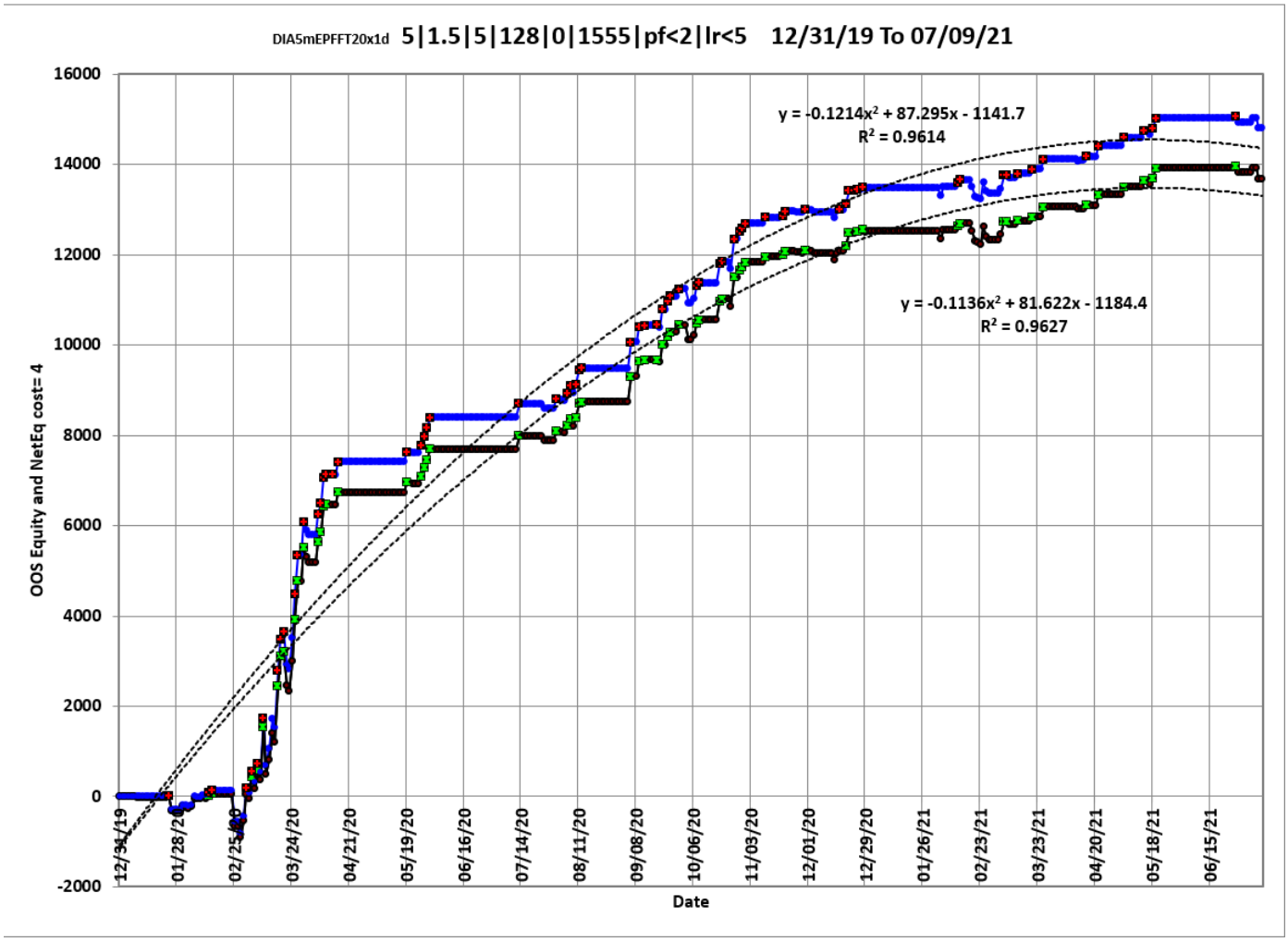

Figure 2 Walk Forward Out-Of-Sample Performance Summary for EPFFT Strategy DIA 5-minute bar chart from 5/13/21 to 5/19/21

Figure 3 Partial output of the Walk Forward Strategy Inputs with Metric Filters (WFINP) DIA ETF 5 min bars Using The EPFFT Strategy

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA
1	DIA5mEPFFT20x1d	s12/31/19	e07/09/21	#399	AnyTnp						lSnt2			a(3.8)	s9.6	f431999					c=$4						
2	thr|pup|pdn|nsamp|xop|xt|<PF<LR<R2	toGP	tONP	aoGP	aoTr	ao#T	std	skew	kur	t	oW|oL	%Wtr	%P	LLtr	LLp	eqDD	wpr	lpr	#	V20	Dev^2	KTau	eqR2	Blw	BE	tkr|bl	Prob
3	5|1.5|5|128|0|1555|pf<2|lr<5	14801	13673	109	52.5	2.1	303	0.602	6.96	4.19	1.4	59	66	-983	-1040	-1040	7	4	136	16	1720	95	87	32	96	1134	5.00E-17
4	5|1.5|5|128|0|1555|pf<2|	14577	13317	97	46.3	2.1	314	0.43	6.34	3.79	1.38	57	65	-983	-1040	-1259	7	4	150	16	1677	94	87	32	117	836	1.11E-16
5	5|1.5|5|128|0|1555|pf<3|lr<5	14104	12812	88	43.7	2	311	0.356	6.51	3.58	1.33	57	63	-983	-1040	-1040	8	4	160	6	1733	92	86	53	131	411	5.00E-17
6	5|1.5|5|128|0|1555|pf<3|	14047	12615	80	39.2	2	318	0.262	6.07	3.34	1.33	55	62	-983	-1040	-1259	8	4	175	6	1721	92	86	53	151	331	1.67E-15
7	15|3.5|2|896|0|1555|lr<3	12299	11375	64	53.2	1.2	199	1.761	8.44	4.47	1.72	59	61	-322	-431	-841	12	4	191	-3	1991	69	77	86	84	329	2.50E-11
8	5|1.5|5|128|0|1555|pf<2|lr<5r2<80	12150	11206	100	51.5	1.9	285	0.765	8.57	3.86	1.4	59	66	-983	-1040	-1040	7	4	122	16	1134	95	92	32	113	936	3.33E-16
9	15|3.5|3.5|896|0|1555|	11916	11060	61	55.7	1.1	225	0.987	7.01	3.79	1.5	59	60	-526	-749	-1004	11	4	196	-2	1979	81	76	90	117	221	2.10E-10
10	15|3.5|3.5|896|0|1555|lr<5	11916	11060	61	55.7	1.1	225	0.987	7.01	3.79	1.5	59	60	-526	-749	-1004	11	4	196	-2	1979	81	76	90	117	221	2.10E-10
11	5|1.5|5|128|0|1555|pf<2|r2<80	11926	10850	88	44.3	2	299	0.509	7.44	3.42	1.37	57	65	-983	-1040	-1259	7	4	136	16	1102	94	92	32	143	644	3.33E-16
12	15|3.5|2|896|0|1555|lr<5	11594	10554	54	44.6	1.2	210	1.259	7.58	3.77	1.4	59	60	-603	-526	-1732	12	7	215	-1	1763	74	79	86	118	216	2.07E-08
13	15|3.5|2|896|0|1555|	11594	10554	54	44.6	1.2	210	1.259	7.58	3.77	1.4	59	60	-603	-526	-1732	12	7	215	-1	1763	74	79	86	118	216	2.07E-08
14	15|3.5|3|896|0|1555|lr<5	11324	10436	56	51	1.1	218	1.055	6.17	3.66	1.49	58	58	-526	-539	-986	11	5	201	2	1753	82	77	90	125	204	3.76E-09
15	15|3.5|3|896|0|1555|	11324	10436	56	51	1.1	218	1.055	6.17	3.66	1.49	58	58	-526	-539	-986	11	5	201	2	1753	82	77	90	125	204	3.76E-09

The WFINP Filter Output Columns are defined as follows: OOS=out-of-sample

Row 1 DIA5Fixm20x1dxo is the PWFO output files abbreviation, First OOS Day End Date (12/09/19), Last OOS Day End Date (07/09/21), **Number of days**(#399) **a**=average of bootstrap random picks. **s**= standard deviation of bootstrap random picks. **f**=number of different filters examined. **c**= slippage and round-trip trade cost(c=$4).

The WFINP AVE File Output Cols are defined as follows

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

  Col A: ***The Strategy Input/Filter Names***
  Row 3: **5|1.5|5|128|0|1555|pf<2|lr<5**: The strategy inputs **5|1.5|5|128|0|1555|**for all in-sample files that have **PF≤2 and lr ≤5**.
  Col B: ***toGP*** Total out-of-sample(oos) gross profit for these 399 oos periods (for this run periods = weeks).
  Col C: ***toNP*** Total out-of-sample(oos) Net profit (toGP-Number Of Trade Weeks*cost) for the 399 oos periods.
  Col D: ***aoGP*** Average oos gross profit for the # oos periods
  Col E: ***aoTr*** Average oos profit per trade
  Col F: ***ao#T*** Average number of oos trades per week
  Col G: ***std*** The standard deviation of the # oos period profits and losses
  Col H: ***skew*** The Skew statistic of the # oos period profits and losses
  Col I: ***kur*** The kurtosis statistic of the # oos period profits and losses
  Col J: ***t*** The student t statistic for the # oos periods. The higher the t statistic the higher the probability that this result was not due to pure chance
  Col K: ***oW|oL*** Ratio of average oos winning trades divided by average oos losing trades.
  Col L: ***%Wtr*** The percentage if oos winning trades
  Col M: ***%P*** percent of all oos periods that were profitable.
  Col N: ***LLtr*** The largest losing oos trade in all oos periods
  Col O: ***LLp*** The largest losing oos period
  Col P: ***eqDD*** The oos equity drawdown
  Col Q: ***wpr*** The largest number of winning oos periods (weeks) in a row.
  Col R: ***lpr*** The largest number of losing oos periods in a row
  Col S: ***#*** The number of oos periods this filter produced any profit or loss. Note for some oos periods there can be no strategy inputs that satisfy a given filters criteria, and no trades will be made during that period.
  Col T: ***v20 The*** straight-line trend of the oos equity curve for the last 20 bars.
  Col U: ***Dev^2*** A measure of equity curve smoothness. The square root of the average (equity curve minus a straight line)^2)

Col V: ***KTau*** The Kendall rank coefficient is often used as a test statistic in a statistical hypothesis test to establish whether two variables may be regarded as statistically dependent. This test is non-parametric, as it does not rely on any assumptions on the distributions of X or Y or the distribution of (X,Y)
Col W: ***eqR2*** The correlation coefficient(R^2) of a straight line fit to the equity curve.
Col X: ***Blw*** The maximum number of oos periods the oos equity curve failed to make a new high.
Col Y: ***BE*** Break even in oos periods. Assuming the average and standard deviation are from a normal distribution, this is the number of oos periods you would have to trade to have a 98% probability that your oos equity is above zero.
Col Z: ***tkr/bl*** =100*t*Ktau*eqR2/Blw/BE. This is measure of the best equity curve.
Col AA: ***Prob*** The probability that the filters oos toNP was due to pure chance. Row 1 lists the random bootstrap average for the 399 out-of-sample files of **-$3.8** with a bootstrap standard deviation of **$9.6**. (Side Note. The average is the average per out-of-sample period. So, the average for the random selection would be the ***random toNP/399*** and the average for the filter would be the filter ***toNP/# of OOS periods*** traded or 13673/136=100.5). The probability of obtaining our filters average daily net profit of **100.5** is $\mathbf{5x10^{-17}}$ which is **10.81** standard deviations from the bootstrap average. For our filter, in row 3 above, the expected number of cases that we could obtain by pure chance that would match or exceed **$100.5** is $[1-(1-\mathbf{5x10^{-17}})^{432000}]$ ~= $\mathbf{432000*5x10^{-17}} = 2.2x\ 10^{-11}$ where **432000** is the total number of different filters we looked at in this run. This number is much much less than one, so it is improbable that our result was due to pure chance
.

Table 1 Walk Forward Out-Of-Sample Performance Summary for the DIA 5-min EPFFT Strategy

DIA-5 min bars 12/9/2019 - 7/9/2021.

Filter: **5|1.5|5|128|0|1555|pf<2|lr<5**: The strategy inputs **5|1.5|5|128|0|1555|** for all in-sample files that have **PF≤2 and lr ≤5**.
are used to trade in the following out-of-sample sections.
IS-pf = In-sample pf
IS-lr = in-sample losers-in-a-row
osnp = Daily out-of-sample gross profit in $
NOnp$4 = Daily out-of-sample net profit in $ = **osnp-ont*4**.
ont = The number of trades in the out-of-sample day
ownp = winning profits in the out-of-sample day.
ownt = number of winning trades in the out-of-sample day
ollt = The largest losing trade in the out-of-sample day in $.
odd = The drawdown in the out-of-sample day in $.
EQ=Equity = Running Sum of daily out-of-sample gross profits $
NetEq=Net Equity = running sum of the daily out-of-sample net profits in $
Note1: Blank rows indicate that no out-of-sample trades were made that day
Note2: if IS nT<2 then no trades were made in out-of-sample section

Date	IS pf	IS lr	osnp	NOnp$4	ont	ownp	ownt	ollt	odd	EQ	NetEq
12/31/19	2.83	2	0	0	0	0	0	0	0	0	0
01/01/20	3.77	2	0	0	0	0	0	0	0	0	0
01/02/20	3.77	2	0	0	0	0	0	0	0	0	0
01/03/20	3.77	2	0	0	0	0	0	0	0	0	0
01/06/20	2.89	2	0	0	0	0	0	0	0	0	0
01/07/20	0.98	2	0	0	0	0	0	0	0	0	0
01/08/20	0.98	2	(10)	(14)	1	0	0	-10	-10	(10)	(14)
01/09/20	0.83	2	0	0	0	0	0	0	0	(10)	(14)
01/10/20	0.48	2	0	0	0	0	0	0	0	(10)	(14)
01/13/20	0.48	2	0	0	0	0	0	0	0	(10)	(14)
01/14/20	0.48	2	0	0	0	0	0	0	0	(10)	(14)
01/15/20	0.48	2	0	0	0	0	0	0	0	(10)	(14)
01/16/20	0.48	2	0	0	0	0	0	0	0	(10)	(14)
01/17/20	0.48	2	0	0	0	0	0	0	0	(10)	(14)
01/20/20	0.48	2	0	0	0	0	0	0	0	(10)	(14)
01/21/20	0.48	2	0	0	0	0	0	0	0	(10)	(14)
01/22/20	0.52	2	0	0	0	0	0	0	0	(10)	(14)
01/23/20	0.49	2	34	26	2	86	1	-52	-52	24	12
01/24/20	0.51	3	(317)	(329)	3	6	1	-263	-323	(293)	(317)
01/27/20	0.28	3	0	0	0	0	0	0	0	(293)	(317)
01/28/20	0.32	3	0	0	0	0	0	0	0	(293)	(317)
01/29/20	0.16	3	0	0	0	0	0	0	0	(293)	(317)
01/30/20	0.16	3	94	90	1	94	1	0	0	(199)	(227)
01/31/20	0.32	3	(8)	(12)	1	0	0	-8	-8	(207)	(239)
02/03/20	0.31	3	(19)	(23)	1	0	0	-19	-19	(226)	(262)
02/04/20	0.45	2	33	29	1	33	1	0	0	(193)	(233)
02/05/20	0.53	2	194	190	1	194	1	0	0	1	(43)
02/06/20	1.03	2	(14)	(18)	1	0	0	-14	-14	(13)	(61)
02/07/20	0.99	2	0	0	0	0	0	0	0	(13)	(61)
02/10/20	0.99	2	28	24	1	28	1	0	0	15	(37)
02/11/20	1.06	2	(2)	(6)	1	0	0	-2	-2	13	(43)
02/12/20	1.06	2	71	67	1	71	1	0	0	84	24

Date	IS pf	IS lr	osnp	NOnp$4	ont	ownp	ownt	ollt	odd	EQ	NetEq
02/13/20	1.22	2	47	43	1	47	1	0	0	131	67
02/14/20	1.34	2	(10)	(14)	1	0	0	-10	-10	121	53
02/17/20	1.31	2	0	0	0	0	0	0	0	121	53
02/18/20	1.31	2	0	0	0	0	0	0	0	121	53
02/19/20	1.31	2	0	0	0	0	0	0	0	121	53
02/20/20	1.31	2	(6)	(14)	2	96	1	-102	-102	115	39
02/21/20	1.19	2	13	9	1	13	1	0	0	128	48
02/24/20	3.72	2	0	0	0	0	0	0	0	128	48
02/25/20	1.32	2	(691)	(703)	3	0	0	-593	-691	(563)	(655)
02/26/20	0.51	5	0	0	0	0	0	0	0	(563)	(655)
02/27/20	0.51	5	(253)	(261)	2	143	1	-396	-396	(816)	(916)
02/29/20	0.41	5	380	364	4	449	2	-37	-69	(436)	(552)
03/02/20	0.68	5	611	603	2	689	1	-78	-78	175	51
03/03/20	1.07	5	(93)	(101)	2	0	0	-91	-93	82	(50)
03/04/20	1	5	482	478	1	482	1	0	0	564	428
03/05/20	1.16	5	(242)	(258)	4	66	2	-281	-281	322	170
03/06/20	1.03	5	413	405	2	453	1	-40	-40	735	575
03/09/20	1.23	5	(193)	(209)	4	347	1	-359	-439	542	366
03/10/20	1.09	5	1186	1178	2	1186	2	0	0	1728	1544
03/11/20	1.55	5	(1040)	(1056)	4	0	0	-680	-1040	688	488
03/12/20	1.09	5	363	315	12	1143	6	-449	-511	1051	803
03/13/20	1.14	5	660	608	13	1821	9	-663	-864	1711	1411
03/16/20	1.23	5	(195)	(211)	4	841	1	-983	-1006	1516	1200
03/17/20	1.17	5	1258	1242	4	1258	4	0	0	2774	2442
03/18/20	1.36	5	710	654	14	1671	10	-424	-816	3484	3096
03/19/20	1.41	5	156	100	14	622	8	-126	-258	3640	3196
03/20/20	1.41	5	(729)	(753)	6	102	2	-618	-729	2911	2443
03/23/20	1.29	5	(96)	(120)	6	846	3	-708	-942	2815	2323
03/24/20	1.28	4	684	660	6	864	4	-139	-139	3499	2983
03/25/20	1.46	4	974	938	9	1460	5	-213	-486	4473	3921
03/26/20	1.54	4	877	865	3	917	2	-40	-40	5350	4786
03/27/20	1.68	4	(4)	(16)	3	105	2	-109	-109	5346	4770
03/30/20	1.64	4	733	729	1	733	1	0	0	6079	5499
03/31/20	1.66	4	(196)	(204)	2	0	0	-183	-196	5883	5295
04/01/20	1.64	4	(92)	(108)	4	169	2	-140	-261	5791	5187
04/02/20	1.56	4	0	0	0	0	0	0	0	5791	5187
04/03/20	1.6	4	0	0	0	0	0	0	0	5791	5187
04/06/20	1.56	4	460	452	2	474	1	-14	-14	6251	5639
04/07/20	1.67	4	243	227	4	444	2	-174	-174	6494	5866
04/08/20	1.55	4	574	554	5	767	3	-105	-105	7068	6420
04/09/20	1.81	4	56	48	2	56	2	0	0	7124	6468
04/10/20	1.86	4	0	0	0	0	0	0	0	7124	6468
04/13/20	1.91	4	2	(6)	2	12	1	-10	-10	7126	6462
04/14/20	2.15	4	0	0	0	0	0	0	0	7126	6462
04/15/20	1.93	4	276	268	2	276	2	0	0	7402	6730
04/16/20	2.04	4	0	0	0	0	0	0	0	7402	6730
04/17/20	2.14	4	0	0	0	0	0	0	0	7402	6730
04/20/20	2.88	4	0	0	0	0	0	0	0	7402	6730
04/21/20	3.31	4	0	0	0	0	0	0	0	7402	6730
04/22/20	2.75	4	0	0	0	0	0	0	0	7402	6730
04/23/20	2.68	4	0	0	0	0	0	0	0	7402	6730
04/24/20	2.18	4	0	0	0	0	0	0	0	7402	6730
04/27/20	2.27	4	0	0	0	0	0	0	0	7402	6730
04/28/20	1.78	4	0	0	0	0	0	0	0	7402	6730
04/29/20	2.04	4	0	0	0	0	0	0	0	7402	6730
04/30/20	2.39	4	0	0	0	0	0	0	0	7402	6730
05/01/20	2.19	6	0	0	0	0	0	0	0	7402	6730
05/04/20	2.19	6	0	0	0	0	0	0	0	7402	6730

Date	IS pf	IS lr	osnp	NOnp$4	ont	ownp	ownt	ollt	odd	EQ	NetEq
05/05/20	1.88	7	0	0	0	0	0	0	0	7402	6730
05/06/20	1.72	7	0	0	0	0	0	0	0	7402	6730
05/07/20	0.83	7	0	0	0	0	0	0	0	7402	6730
05/08/20	0.78	7	0	0	0	0	0	0	0	7402	6730
05/11/20	0.78	7	0	0	0	0	0	0	0	7402	6730
05/12/20	0.88	7	0	0	0	0	0	0	0	7402	6730
05/13/20	0.74	7	0	0	0	0	0	0	0	7402	6730
05/14/20	0.39	7	0	0	0	0	0	0	0	7402	6730
05/15/20	0.84	7	0	0	0	0	0	0	0	7402	6730
05/18/20	0.67	7	0	0	0	0	0	0	0	7402	6730
05/19/20	0.83	5	226	218	2	268	1	-42	-42	7628	6948
05/20/20	1.23	3	0	0	0	0	0	0	0	7628	6948
05/21/20	1.23	3	(29)	(33)	1	0	0	-29	-29	7599	6915
05/22/20	1.21	3	0	0	0	0	0	0	0	7599	6915
05/25/20	1.21	3	0	0	0	0	0	0	0	7599	6915
05/26/20	1.21	3	174	170	1	174	1	0	0	7773	7085
05/27/20	1.35	3	200	196	1	200	1	0	0	7973	7281
05/28/20	1.52	3	185	177	2	199	1	-14	-14	8158	7458
05/29/20	1.81	3	230	226	1	230	1	0	0	8388	7684
06/01/20	2.02	3	0	0	0	0	0	0	0	8388	7684
06/02/20	1.93	3	0	0	0	0	0	0	0	8388	7684
06/03/20	2.05	3	0	0	0	0	0	0	0	8388	7684
06/04/20	3.68	3	0	0	0	0	0	0	0	8388	7684
06/05/20	3.55	3	0	0	0	0	0	0	0	8388	7684
06/08/20	3.47	3	0	0	0	0	0	0	0	8388	7684
06/09/20	2.48	3	0	0	0	0	0	0	0	8388	7684
06/10/20	2.41	3	0	0	0	0	0	0	0	8388	7684
06/11/20	3.78	4	0	0	0	0	0	0	0	8388	7684
06/12/20	0.76	8	0	0	0	0	0	0	0	8388	7684
06/15/20	0.6	14	0	0	0	0	0	0	0	8388	7684
06/16/20	0.67	14	0	0	0	0	0	0	0	8388	7684
06/17/20	0.61	14	0	0	0	0	0	0	0	8388	7684
06/18/20	0.57	14	0	0	0	0	0	0	0	8388	7684
06/19/20	0.6	14	0	0	0	0	0	0	0	8388	7684
06/22/20	0.59	14	0	0	0	0	0	0	0	8388	7684
06/23/20	0.64	14	0	0	0	0	0	0	0	8388	7684
06/24/20	0.59	14	0	0	0	0	0	0	0	8388	7684
06/25/20	0.67	14	0	0	0	0	0	0	0	8388	7684
06/26/20	0.63	14	0	0	0	0	0	0	0	8388	7684
06/29/20	0.57	14	0	0	0	0	0	0	0	8388	7684
06/30/20	0.57	14	0	0	0	0	0	0	0	8388	7684
07/01/20	0.57	14	0	0	0	0	0	0	0	8388	7684
07/02/20	0.57	14	0	0	0	0	0	0	0	8388	7684
07/03/20	0.57	14	0	0	0	0	0	0	0	8388	7684
07/06/20	0.49	14	0	0	0	0	0	0	0	8388	7684
07/07/20	0.52	12	0	0	0	0	0	0	0	8388	7684
07/08/20	0.53	11	0	0	0	0	0	0	0	8388	7684
07/09/20	0.55	10	0	0	0	0	0	0	0	8388	7684
07/10/20	0.91	6	0	0	0	0	0	0	0	8388	7684
07/13/20	1.63	3	306	302	1	306	1	0	0	8694	7986
07/14/20	2.32	3	0	0	0	0	0	0	0	8694	7986
07/15/20	3.87	2	0	0	0	0	0	0	0	8694	7986
07/16/20	5.33	2	0	0	0	0	0	0	0	8694	7986
07/17/20	6.16	2	0	0	0	0	0	0	0	8694	7986
07/20/20	13.84	1	0	0	0	0	0	0	0	8694	7986
07/21/20	4.51	1	0	0	0	0	0	0	0	8694	7986
07/22/20	3.78	1	0	0	0	0	0	0	0	8694	7986
07/23/20	2.38	1	0	0	0	0	0	0	0	8694	7986

Date	IS pf	IS lr	osnp	NOnp$4	ont	ownp	ownt	ollt	odd	EQ	NetEq
07/24/20	1.6	2	(100)	(104)	1	0	0	-100	-100	8594	7882
07/27/20	1.37	2	0	0	0	0	0	0	0	8594	7882
07/28/20	1.37	2	0	0	0	0	0	0	0	8594	7882
07/29/20	1.37	2	0	0	0	0	0	0	0	8594	7882
07/30/20	1.37	2	204	196	2	204	2	0	0	8798	8078
07/31/20	1.67	2	0	0	0	0	0	0	0	8798	8078
08/03/20	1.67	2	0	0	0	0	0	0	0	8798	8078
08/04/20	1.67	2	(29)	(33)	1	0	0	-29	-29	8769	8045
08/05/20	1.6	2	163	159	1	163	1	0	0	8932	8204
08/06/20	1.83	2	169	165	1	169	1	0	0	9101	8369
08/07/20	1.92	2	(170)	(174)	1	0	0	-170	-170	8931	8195
08/10/20	1.55	2	199	195	1	199	1	0	0	9130	8390
08/11/20	1.43	2	317	309	2	372	1	-55	-55	9447	8699
08/12/20	1.26	2	32	28	1	32	1	0	0	9479	8727
08/13/20	1.46	2	0	0	0	0	0	0	0	9479	8727
08/14/20	1.46	2	0	0	0	0	0	0	0	9479	8727
08/17/20	1.46	2	0	0	0	0	0	0	0	9479	8727
08/18/20	1.9	2	0	0	0	0	0	0	0	9479	8727
08/19/20	2.1	1	0	0	0	0	0	0	0	9479	8727
08/20/20	2.1	1	0	0	0	0	0	0	0	9479	8727
08/21/20	3.53	1	0	0	0	0	0	0	0	9479	8727
08/24/20	4.93	1	0	0	0	0	0	0	0	9479	8727
08/25/20	4.93	1	0	0	0	0	0	0	0	9479	8727
08/26/20	4.93	1	0	0	0	0	0	0	0	9479	8727
08/27/20	4.93	1	0	0	0	0	0	0	0	9479	8727
08/28/20	4.12	1	0	0	0	0	0	0	0	9479	8727
08/31/20	4.12	1	0	0	0	0	0	0	0	9479	8727
09/01/20	4.26	1	0	0	0	0	0	0	0	9479	8727
09/02/20	5.37	1	0	0	0	0	0	0	0	9479	8727
09/03/20	4.64	1	0	0	0	0	0	0	0	9479	8727
09/04/20	1.4	2	581	573	2	581	2	0	0	10060	9300
09/07/20	2.76	2	0	0	0	0	0	0	0	10060	9300
09/08/20	2.43	2	0	0	0	0	0	0	0	10060	9300
09/09/20	1.62	2	341	337	1	341	1	0	0	10401	9637
09/10/20	2.07	2	0	0	0	0	0	0	0	10401	9637
09/11/20	0.87	4	27	23	1	27	1	0	0	10428	9660
09/14/20	0.88	4	0	0	0	0	0	0	0	10428	9660
09/15/20	0.88	4	0	0	0	0	0	0	0	10428	9660
09/16/20	0.88	4	0	0	0	0	0	0	0	10428	9660
09/17/20	0.88	4	12	4	2	105	1	-93	-93	10440	9664
09/18/20	0.83	4	(48)	(52)	1	0	0	-48	-48	10392	9612
09/21/20	0.81	4	393	385	2	393	2	0	0	10785	9997
09/22/20	1.03	4	0	0	0	0	0	0	0	10785	9997
09/23/20	1.03	4	185	181	1	185	1	0	0	10970	10178
09/24/20	1.13	4	106	102	1	106	1	0	0	11076	10280
09/25/20	1.19	4	0	0	0	0	0	0	0	11076	10280
09/28/20	1.19	4	0	0	0	0	0	0	0	11076	10280
09/29/20	1.17	4	165	157	2	165	2	0	0	11241	10437
09/30/20	1.19	4	0	0	0	0	0	0	0	11241	10437
10/01/20	1.19	4	0	0	0	0	0	0	0	11241	10437
10/02/20	1.55	4	(305)	(313)	2	0	0	-225	-305	10936	10124
10/05/20	0.88	4	0	0	0	0	0	0	0	10936	10124
10/06/20	0.88	4	91	87	1	91	1	0	0	11027	10211
10/07/20	1.01	4	272	268	1	272	1	0	0	11299	10479
10/08/20	0.96	4	78	74	1	78	1	0	0	11377	10553
10/09/20	3.19	2	0	0	0	0	0	0	0	11377	10553
10/12/20	2.88	2	0	0	0	0	0	0	0	11377	10553
10/13/20	3.01	2	0	0	0	0	0	0	0	11377	10553

Date	IS pf	IS lr	osnp	NOnp$4	ont	ownp	ownt	ollt	odd	EQ	NetEq
10/14/20	2.95	2	0	0	0	0	0	0	0	11377	10553
10/15/20	2.02	2	0	0	0	0	0	0	0	11377	10553
10/16/20	2.15	2	0	0	0	0	0	0	0	11377	10553
10/19/20	1.96	3	413	409	1	413	1	0	0	11790	10962
10/20/20	1.99	3	53	49	1	53	1	0	0	11843	11011
10/21/20	2.06	3	0	0	0	0	0	0	0	11843	11011
10/22/20	1.8	3	0	0	0	0	0	0	0	11843	11011
10/23/20	1.64	3	(168)	(172)	1	0	0	-168	-168	11675	10839
10/26/20	1.32	3	667	659	2	667	2	0	0	12342	11498
10/27/20	2.1	3	0	0	0	0	0	0	0	12342	11498
10/28/20	1.91	3	154	146	2	265	1	-111	-111	12496	11644
10/29/20	1.96	3	86	78	2	269	1	-183	-183	12582	11722
10/30/20	1.88	3	109	101	2	109	2	0	0	12691	11823
11/02/20	2.69	3	0	0	0	0	0	0	0	12691	11823
11/03/20	2.62	3	0	0	0	0	0	0	0	12691	11823
11/04/20	2.68	3	0	0	0	0	0	0	0	12691	11823
11/05/20	3.03	3	0	0	0	0	0	0	0	12691	11823
11/06/20	3.09	3	0	0	0	0	0	0	0	12691	11823
11/09/20	3.01	3	0	0	0	0	0	0	0	12691	11823
11/10/20	1.72	4	128	124	1	128	1	0	0	12819	11947
11/11/20	1.82	4	0	0	0	0	0	0	0	12819	11947
11/12/20	2.14	4	0	0	0	0	0	0	0	12819	11947
11/13/20	2.14	4	0	0	0	0	0	0	0	12819	11947
11/16/20	2.33	4	0	0	0	0	0	0	0	12819	11947
11/17/20	1.99	4	0	0	0	0	0	0	0	12819	11947
11/18/20	1.94	4	39	35	1	39	1	0	0	12858	11982
11/19/20	1.98	4	96	92	1	96	1	0	0	12954	12074
11/20/20	2.06	4	0	0	0	0	0	0	0	12954	12074
11/23/20	2.39	4	0	0	0	0	0	0	0	12954	12074
11/24/20	1.74	4	0	0	0	0	0	0	0	12954	12074
11/25/20	1.74	4	(7)	(15)	2	4	1	-11	-11	12947	12059
11/26/20	1.65	4	0	0	0	0	0	0	0	12947	12059
11/27/20	1.69	4	(15)	(19)	1	0	0	-15	-15	12932	12040
11/30/20	1.51	4	59	55	1	59	1	0	0	12991	12095
12/01/20	1.63	4	0	0	0	0	0	0	0	12991	12095
12/02/20	1.43	4	(5)	(13)	2	112	1	-117	-117	12986	12082
12/03/20	0.68	4	(43)	(47)	1	0	0	-43	-43	12943	12035
12/04/20	0.49	4	0	0	0	0	0	0	0	12943	12035
12/07/20	0.53	3	0	0	0	0	0	0	0	12943	12035
12/08/20	2.35	2	0	0	0	0	0	0	0	12943	12035
12/09/20	1.67	2	0	0	0	0	0	0	0	12943	12035
12/10/20	1.67	2	0	0	0	0	0	0	0	12943	12035
12/11/20	1.67	2	0	0	0	0	0	0	0	12943	12035
12/14/20	1.67	2	(139)	(147)	2	98	1	-237	-237	12804	11888
12/15/20	0.96	2	147	143	1	147	1	0	0	12951	12031
12/16/20	1.31	2	45	41	1	45	1	0	0	12996	12072
12/17/20	1.33	2	0	0	0	0	0	0	0	12996	12072
12/18/20	1.1	2	126	122	1	126	1	0	0	13122	12194
12/21/20	1.4	2	282	278	1	282	1	0	0	13404	12472
12/22/20	2.06	2	0	0	0	0	0	0	0	13404	12472
12/23/20	1.78	2	3	(1)	1	3	1	0	0	13407	12471
12/24/20	1.82	2	29	25	1	29	1	0	0	13436	12496
12/25/20	1.88	2	0	0	0	0	0	0	0	13436	12496
12/28/20	1.97	2	65	61	1	65	1	0	0	13501	12557
12/29/20	1.95	2	(55)	(59)	1	0	0	-55	-55	13446	12498
12/30/20	1.75	2	25	21	1	25	1	0	0	13471	12519
12/31/20	2.04	2	0	0	0	0	0	0	0	13471	12519
01/01/21	2.55	1	0	0	0	0	0	0	0	13471	12519

Date	IS pf	IS lr	osnp	NOnp$4	ont	ownp	ownt	ollt	odd	EQ	NetEq
01/04/21	2.55	1	0	0	0	0	0	0	0	13471	12519
01/05/21	4.15	1	0	0	0	0	0	0	0	13471	12519
01/06/21	4.15	1	0	0	0	0	0	0	0	13471	12519
01/07/21	4.15	1	0	0	0	0	0	0	0	13471	12519
01/08/21	3.72	1	0	0	0	0	0	0	0	13471	12519
01/11/21	4.9	1	0	0	0	0	0	0	0	13471	12519
01/12/21	11.39	1	0	0	0	0	0	0	0	13471	12519
01/13/21	11.66	1	0	0	0	0	0	0	0	13471	12519
01/14/21	10.49	1	0	0	0	0	0	0	0	13471	12519
01/15/21	4.68	2	0	0	0	0	0	0	0	13471	12519
01/18/21	4.27	3	0	0	0	0	0	0	0	13471	12519
01/19/21	3.61	3	0	0	0	0	0	0	0	13471	12519
01/20/21	4.28	3	0	0	0	0	0	0	0	13471	12519
01/21/21	4.27	3	0	0	0	0	0	0	0	13471	12519
01/22/21	4.11	3	0	0	0	0	0	0	0	13471	12519
01/25/21	4.19	3	0	0	0	0	0	0	0	13471	12519
01/26/21	3.76	3	0	0	0	0	0	0	0	13471	12519
01/27/21	4.35	3	0	0	0	0	0	0	0	13471	12519
01/28/21	2.92	3	0	0	0	0	0	0	0	13471	12519
01/29/21	2.74	3	0	0	0	0	0	0	0	13471	12519
02/01/21	1.59	4	0	0	0	0	0	0	0	13471	12519
02/02/21	1	4	0	0	0	0	0	0	0	13471	12519
02/03/21	1	4	(155)	(163)	2	0	0	-135	-155	13316	12356
02/04/21	0.86	4	185	181	1	185	1	0	0	13501	12537
02/05/21	1.07	4	0	0	0	0	0	0	0	13501	12537
02/08/21	0.63	4	0	0	0	0	0	0	0	13501	12537
02/09/21	0.63	4	0	0	0	0	0	0	0	13501	12537
02/10/21	0.45	4	0	0	0	0	0	0	0	13501	12537
02/11/21	0.46	4	89	85	1	89	1	0	0	13590	12622
02/12/21	0.68	4	66	62	1	66	1	0	0	13656	12684
02/15/21	0.68	4	0	0	0	0	0	0	0	13656	12684
02/16/21	0.68	4	0	0	0	0	0	0	0	13656	12684
02/17/21	0.68	4	0	0	0	0	0	0	0	13656	12684
02/18/21	0.68	4	(162)	(166)	1	0	0	-162	-162	13494	12518
02/19/21	0.57	4	(214)	(222)	2	0	0	-126	-214	13280	12296
02/22/21	0.47	4	(22)	(26)	1	0	0	-22	-22	13258	12270
02/23/21	0.42	4	(34)	(38)	1	0	0	-34	-34	13224	12232
02/24/21	0.41	5	378	374	1	378	1	0	0	13602	12606
02/25/21	0.79	5	(191)	(203)	3	104	1	-184	-191	13411	12403
02/26/21	0.69	5	(60)	(68)	2	0	0	-48	-60	13351	12335
03/01/21	0.87	5	0	0	0	0	0	0	0	13351	12335
03/02/21	0.87	5	0	0	0	0	0	0	0	13351	12335
03/03/21	0.87	5	0	0	0	0	0	0	0	13351	12335
03/04/21	1.04	5	109	101	2	109	2	0	0	13460	12436
03/05/21	0.95	5	297	293	1	297	1	0	0	13757	12729
03/08/21	1.33	5	8	4	1	8	1	0	0	13765	12733
03/09/21	1.34	5	(65)	(69)	1	0	0	-65	-65	13700	12664
03/10/21	1.23	5	0	0	0	0	0	0	0	13700	12664
03/11/21	1.23	5	10	6	1	10	1	0	0	13710	12670
03/12/21	1.14	5	86	82	1	86	1	0	0	13796	12752
03/15/21	1.16	5	0	0	0	0	0	0	0	13796	12752
03/16/21	1.16	5	0	0	0	0	0	0	0	13796	12752
03/17/21	1.16	5	0	0	0	0	0	0	0	13796	12752
03/18/21	1.16	5	0	0	0	0	0	0	0	13796	12752
03/19/21	1.44	4	89	81	2	89	2	0	0	13885	12833
03/22/21	2.27	3	0	0	0	0	0	0	0	13885	12833
03/23/21	2.38	3	0	0	0	0	0	0	0	13885	12833
03/24/21	2.57	3	0	0	0	0	0	0	0	13885	12833

Date	IS pf	IS lr	osnp	NOnp$4	ont	ownp	ownt	ollt	odd	EQ	NetEq
03/25/21	1.67	3	224	216	2	315	1	-91	-91	14109	13049
03/26/21	4.23	2	0	0	0	0	0	0	0	14109	13049
03/29/21	5.86	1	0	0	0	0	0	0	0	14109	13049
03/30/21	5.86	1	0	0	0	0	0	0	0	14109	13049
03/31/21	5.86	1	0	0	0	0	0	0	0	14109	13049
04/01/21	5.86	1	0	0	0	0	0	0	0	14109	13049
04/02/21	5.16	1	0	0	0	0	0	0	0	14109	13049
04/05/21	3.26	1	0	0	0	0	0	0	0	14109	13049
04/06/21	3.21	1	0	0	0	0	0	0	0	14109	13049
04/07/21	5.49	1	0	0	0	0	0	0	0	14109	13049
04/08/21	5.49	1	0	0	0	0	0	0	0	14109	13049
04/09/21	5.38	1	0	0	0	0	0	0	0	14109	13049
04/12/21	1.78	1	(43)	(47)	1	0	0	-43	-43	14066	13002
04/13/21	1.5	2	15	11	1	15	1	0	0	14081	13013
04/14/21	1.55	2	13	9	1	13	1	0	0	14094	13022
04/15/21	1.6	2	87	83	1	87	1	0	0	14181	13105
04/16/21	1.92	2	0	0	0	0	0	0	0	14181	13105
04/19/21	1.59	2	(16)	(20)	1	0	0	-16	-16	14165	13085
04/20/21	1.5	2	0	0	0	0	0	0	0	14165	13085
04/21/21	1.5	2	238	234	1	238	1	0	0	14403	13319
04/22/21	2.34	2	0	0	0	0	0	0	0	14403	13319
04/23/21	1.81	2	0	0	0	0	0	0	0	14403	13319
04/26/21	1.81	2	0	0	0	0	0	0	0	14403	13319
04/27/21	1.81	2	0	0	0	0	0	0	0	14403	13319
04/28/21	1.81	2	0	0	0	0	0	0	0	14403	13319
04/29/21	1.81	2	0	0	0	0	0	0	0	14403	13319
04/30/21	1.81	2	0	0	0	0	0	0	0	14403	13319
05/03/21	1.81	2	0	0	0	0	0	0	0	14403	13319
05/04/21	1.81	2	184	176	2	187	1	-3	-3	14587	13495
05/05/21	2.73	2	0	0	0	0	0	0	0	14587	13495
05/06/21	2.73	2	0	0	0	0	0	0	0	14587	13495
05/07/21	2.73	2	0	0	0	0	0	0	0	14587	13495
05/10/21	8.71	1	0	0	0	0	0	0	0	14587	13495
05/11/21	28.42	1	0	0	0	0	0	0	0	14587	13495
05/12/21	2.52	1	0	0	0	0	0	0	0	14587	13495
05/13/21	0.72	2	149	145	1	149	1	0	0	14736	13640
05/14/21	0.8	2	0	0	0	0	0	0	0	14736	13640
05/17/21	0.8	2	(76)	(80)	1	0	0	-76	-76	14660	13560
05/18/21	0.74	2	121	117	1	121	1	0	0	14781	13677
05/19/21	0.9	2	241	237	1	241	1	0	0	15022	13914
05/20/21	0.9	2	0	0	0	0	0	0	0	15022	13914
05/21/21	0.9	2	0	0	0	0	0	0	0	15022	13914
05/24/21	0.9	2	0	0	0	0	0	0	0	15022	13914
05/25/21	0.9	2	0	0	0	0	0	0	0	15022	13914
05/26/21	0.9	2	0	0	0	0	0	0	0	15022	13914
05/27/21	0.9	2	0	0	0	0	0	0	0	15022	13914
05/28/21	0.9	2	0	0	0	0	0	0	0	15022	13914
05/31/21	0.9	2	0	0	0	0	0	0	0	15022	13914
06/01/21	0.9	2	0	0	0	0	0	0	0	15022	13914
06/02/21	0.66	2	0	0	0	0	0	0	0	15022	13914
06/03/21	0.66	2	0	0	0	0	0	0	0	15022	13914
06/04/21	0.66	2	0	0	0	0	0	0	0	15022	13914
06/07/21	0.66	2	0	0	0	0	0	0	0	15022	13914
06/08/21	0.66	2	0	0	0	0	0	0	0	15022	13914
06/09/21	0.88	1	0	0	0	0	0	0	0	15022	13914
06/10/21	6.72	1	0	0	0	0	0	0	0	15022	13914
06/11/21	4.76	1	0	0	0	0	0	0	0	15022	13914
06/14/21	4.76	1	0	0	0	0	0	0	0	15022	13914

Date	IS pf	IS lr	osnp	NOnp$4	ont	ownp	ownt	ollt	odd	EQ	NetEq
06/15/21	99	0	0	0	0	0	0	0	0	15022	13914
06/16/21	99	0	0	0	0	0	0	0	0	15022	13914
06/17/21	0	0	0	0	0	0	0	0	0	15022	13914
06/18/21	0	0	0	0	0	0	0	0	0	15022	13914
06/21/21	0	2	0	0	0	0	0	0	0	15022	13914
06/22/21	0	2	0	0	0	0	0	0	0	15022	13914
06/23/21	0	2	0	0	0	0	0	0	0	15022	13914
06/24/21	0	2	0	0	0	0	0	0	0	15022	13914
06/25/21	0	2	0	0	0	0	0	0	0	15022	13914
06/28/21	0	2	49	45	1	49	1	0	0	15071	13959
06/29/21	0.82	2	(144)	(148)	1	0	0	-144	-144	14927	13811
06/30/21	0.24	2	0	0	0	0	0	0	0	14927	13811
07/01/21	0.24	2	0	0	0	0	0	0	0	14927	13811
07/02/21	0.24	2	0	0	0	0	0	0	0	14927	13811
07/05/21	0.24	2	0	0	0	0	0	0	0	14927	13811
07/06/21	0.24	2	101	97	1	101	1	0	0	15028	13908
07/07/21	0.74	2	0	0	0	0	0	0	0	15028	13908
07/08/21	0.74	2	(227)	(235)	2	0	0	-174	-227	14801	13673
07/09/21	0.35	2	0	0	0	0	0	0	0	14801	13673