Trading 1Min Bar Euro Futures Using The Fading Memory Polynomial Velocity Strategy

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

This is a mathematical technique that fits a n^{th} order polynomial to the last ***T*** price bars but calculates the coefficients of the polynomial such that the error between the current n^{th} order polynomial and the current bar is weighted much higher than the error between the price T bars ago and the value of the n^{th} order polynomial T bars ago. As an example, if the latest price is at time t and the price made a turn at time bar t-10, then we do not want prices prior to t-10 affecting the current polynomial fit as much. As will be shown the most familiar case of this fading memory technique is the exponential moving average. The fading memory technique is in contrast to the Least Squares Polynomial fit, which weights all past errors between the polynomial and the price bar equally.

In previous working papers at http://www.meyersanalytics.com/papers.php we showed how the application of a price curve generated by Nth Order Fixed Memory Polynomial Velocity could be used to develop a strategy to buy and sell futures intraday. The reasoning behind this type of system was to only trade when the price trend velocity was above a certain threshold. Many times prices meander around without any notable trend and this is considered noise. During these times we do not wish to trade because of the cost of whipsaw losses that would occur from this type of price action. When a price trend finally starts, the velocity of that price trend moves above a minimum threshold noise value. Thus the velocity system would only issue a trade when certain velocity thresholds above "noise" levels are crossed.

The velocity system that we will use here to trade the Euro futures contract is called the Nth Order ***Fading*** Memory Adaptive Polynomial Velocity Strategy. The word "Adaptive" is used because the polynomial inputs change over time, adapting to the changing trading patterns of the Euro futures contract. The Nth Order Fading memory Adaptive Polynomial Velocity Strategy has a number of unknown inputs that we have to determine before we can use this strategy to trade. These unknown inputs to the Fading Memory Polynomial are the polynomial order, the optimum number of prices we need to determine the coefficients of the polynomial and finally the velocity thresholds. Here we will use Walk Forward Optimization and out-of-sample performance to determine the "best" polynomial inputs as well as how these inputs should change over time. We will use the nth Order Fading Memory Adaptive Polynomial Velocity System to trade the Euro futures contract on an intraday basis using one minute bar price data. To test this strategy we will use one minute bar prices of the Euro futures contract(EC) traded on the CME/Globex from January 3, 2008 to January 8, 2016.

The n^{th} Order Fading Memory Adaptive Polynomial Velocity Defined

The adaptive n^{th} order Fading Memory Polynomial Velocity is constructed and plotted at each bar by solving for the coefficients $\mathbf{b_1, b_2, b_3, \ldots b_n}$ for the discrete orthogonal Meixner polynomials at each bar using the exponential decay factor $\boldsymbol{\alpha=(1-\beta)}$ and the equation for $\mathbf{b_j}$ shown in the **"Math"** appendix of this paper. Then **Velocity(T+1)** is constructed from the equation shown in the "Math" appendix and plotted under the price chart.

The velocity of a 2^{nd}, 3^{rd} and 4^{th} order polynomial should change faster than the straight line (1^{st} order velocity). As observed from the 2^{nd} order velocity equation in the "Math" section, there is an acceleration component in the calculation of the velocity. This means that the 2^{nd} order velocity will reflect a change in the price trend much faster than the straight line velocity which does not have an acceleration component. The same is true for 3^{rd} and 4^{th} order velocities. Whether higher order polynomial velocities is an advantage or not we will let the computer decide when we let the computer search for the "best" polynomial degree as described below.

At each bar we calculate the n^{th} order (1^{st} through 4^{th}) fading memory polynomial velocity from the formulas in the "Math" appendix. As we will show below, optimization will determine the order for nth order polynomial velocity that will be used. When the velocity is greater than the threshold amount ***vup*** we will go long. When the velocity is less than the threshold amount ***-vdn*** we will go short.

Buy Rule:

IF Velocity is greater than the threshold amount ***vup*** then buy at the market.

Sell Rule:

IF Velocity is less than the threshold amount ***-vdn*** then sell at the market.

The strategy follows the velocity curve. When the velocity is greater than the threshold amount ***vup*** a buy signal is issued. The threshold **vup** serves as a noise filter. That is, price noise creates a lot of small back and forth velocity movement. Unless the velocity can break some threshold to the upside, no trade is issued and the move is considered price noise. The same logic holds for the sell threshold **vdn**.

Intraday Bars Exit Rule:

Close the position at 1350 when U.S trading dies down. (no trades will be carried overnight). Note: Before July 2015 floor trading stopped at 1400 CST

Intraday Bars First Trade of Day Entry Rule:

Ignore all trade signals before **7:00**am. For the Buy and Sell rules above we have included a first trade of the day entry rule. Trading in the EC futures has changed a lot in the last 4 years because of 24hr Globex trading. In particular, trading starts a lot earlier in the morning when Asia and then Europe opens and then dies down. The EC volume starts to pick up again around 7am CST here in the U.S. so we will have the strategy resume trading at 7am.

Discussion of Euro Prices

The Euro(EC) is traded on Globex. On Globex the EC is traded on a 23hour basis . The Old CME hours for floor trading (RTH) are 7:20 to 14:00 CST. Approximately Over 50% of the volume in the EC is done on Globex during the Old CME RTH hours. We have restricted our study to only trading the EC during 7:00 to 1350 hours.

Testing The Polynomial Velocity System Using Walk Forward Optimization

There will be four strategy parameters to determine:

1. **degree**, degree=1 for straight line velocity, degree=2 for 2^{nd} order velocity, etc.
2. **alpha =(1-β)** The exponential decay weight for the Nth Order Fading Memory Polynomial calculation**.**
3. ***vup***, the threshold amount that velocity has to be greater than to issue a buy signal
4. ***vdn***, the threshold amount that velocity has to be less than to issue a sell signal

To test this system we will use one minute bar prices of the Euro(EC) futures contract traded on the CME/Globex and known by the symbol EC for the 439 weeks from November 29, 2007 to January 8, 2016.

We will test this strategy with the above EC 1 min bars on a walk forward basis, as will be described below. To create our walk forward files we will use the ***add-in*** software product called the Power Walk Forward Optimizer (PWFO). In TradeStation (TS), we will run the PWFO strategy ***add-in*** along with the n^{th} Order Fading Memory Polynomial Velocity Strategy on the EC 1min data from November 29, 2007 to January 8, 2016. 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 439 weeks of EC (see Walk forward Testing below) creating 439 out-of-sample weeks.

What Is An In-Sample Section and Out-Of-Sample Section?

Whenever we do a TS optimization on a number of different strategy inputs, TS generates a report of performance metrics (total net profits, number of losing trades, etc) vs these different 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*** or ***test 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" (see Walk Forward Out-of-Sample Testing section below) it is important to see how the strategy inputs chosen from the in-sample section perform on out-of-sample data.

What Does The Power Walk Forward Optimizer (PWFO) Do?

The PWFO is a TS ***add-in*** that breaks up the TS optimization run into a number of user selectable in-sample and out-of-sample sections. The PWFO prints out the in-sample sample performance metrics **and the out-of-sample performance results**, on one line, for each case or input variable combination that is run by the TradeStation(TS) optimization module to a user selected spreadsheet comma delimited file. The PWFO can generate up to 500 different in-sample and out-of-sample date optimization files in one TS run, saving the user from having to generate optimization runs one at a time. The PWFO output allows you to quickly determine whether your procedure for selecting input parameters for your strategy just curve fits the price and noise, or produces statistically valid out-of-sample results. In addition to the out-of-sample performance results presented for each case, 30+ superior and robust performance metrics (many are new and never presented before) are added to each case line in the in-sample section and printed out to the comma delimited file. These 30+ performance metrics allow for a superior and robust selection of input variables from the in-sample section that have a higher probability of performing well on out-of-sample data (Please see Appendix 2 for a listing of these performance metrics).

For our computer run we will have the PWFO breakup the 439 weeks of EC one minute bar price data into 439 in-sample and out-of sample files. The in-sample sections will be 30 calendar days and the out-of-sample(oos) section will be the one week following the in-sample section. The oos week will always end on a Friday as will the 30 day calendar in-sample section. As an example the first in-sample section would be from 11/29/2007 to 12/28/2007 and the out-of-sample section would be the week following from 12/31/2007 to 1/4/2008.(our in-sample and out-of-sample sections always end on a Friday). We would then move everything ahead a week and the 2nd in-sample section would be from 12/6/2007 to 1/4/2008 and the week following out-of-sample section would be from 1/7/2008 to 1/11/2008. Etc.

The PWFO 439 in-sample/out-of-sample section dates are shown in **Table 1** on page 8 below. We will then use another software product called the Walk Forward Performance Metric Explorer (WFME) on each of the 439 in-sample and out-of-sample(oos) sections generated by the PWFO to find the best in-sample section performance ***filter*** that determines the system input parameters ***(degree, N, vup, vdn)*** that will be used on the out-of-sample data. Detailed information about the PWFO and the WFME can be found at www.meyersanalytics.com

For the in-sample data we will run the TradeStation optimization engine on the 439 weeks of EC 1 min bars with the following ranges for the nth order fading memory polynomial velocity strategy input variables.

1. **pw=degree from 1 to 4**
2. **N from 20 to 70 in steps of 10.**
3. **vup from 0.25 to 3 steps of 0.25**
4. **vdn from 0.25 to 3 in steps of 0.25**
5. **Mult = 7600, iNorm=1 (See Appendix 3, the Normalization Multiplier)**

Note: I use **N** because it gives a better understanding of how many bars of past data are approximately being used. **N** and **α (α=1-β)** are approximately related by the formula **α=2/(1+N)**. N is converted to **α** by this formula in the Nth Order Fading Memory Polynomial calculation

This will produce 3456 different cases or combinations of the input parameters for each of the 439 PWFO output files.

Walk Forward Out-of-Sample Testing

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 system, 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*** 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 and 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 system will perform on average. Due to the Central Limit Theorem, as our 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 system and filter. ***Mathematical note:*** *This assumption assumes that the out-of-sample returns are from probability distributions that have a finite variance.*

Why use the walk forward technique? Why not just perform an optimization on the whole price series and choose the input parameters that give the best total net profits or profit factor? Surely the price noise cancels itself out with such a large number of in-sample prices and trades. Unfortunately, nothing could be farther from the truth! Optimization is a misnomer and should really be called combinatorial search. As stated above, whenever we run a combinatorial search over many different combinations of input parameters on noisy data on a fixed number of prices, ***no matter how many***, the best performance parameters found are guaranteed to be due to ***"curve fitting"*** the noise and signal. What do we mean by ***"curve fitting"***? 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 input parameter combinations, the best performance parameters will be from those system 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 movements that were captured by a certain set of input parameters were a large part of the total net profits, then choosing these input parameters will produce losses when traded on future data. These losses occur because the spurious movements will not be repeated in the same way. This is why system optimization, neural net optimizations or combinatorial searches with no out-of-sample testing cause loses when traded in real time by mistaking chance fluctuations for genuine effects. Unfortunately it is human nature to extrapolate past performance to project future trading results and thus results from the chance fluctuations of curve fitting give the illusion, a modern "siren call" so to speak, of future trading profits.

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 three times? Well just as in Poker or any card game, where there is considerable variation in luck from hand to hand, walk forward out-of-sample analysis give considerable variation in week to week out-of-sample profit "luck". That is, by pure chance we may have chosen some input parameter set that did well in the in-sample section data ***and*** the out-of-sample section data. In order to minimize this type of "luck", statistically, we must repeat the walk forward out-of-sample (oos) analysis over many in-sample/oos sections and take an average of our weekly results over all out-of-sample sections. This average gives us an expected weekly return and a standard deviation of weekly returns which allows us to statistically estimate the expected equity and its path ranges for N weeks in the future.

Finding The Strategy Input Parameters in The Walk Forward Test Sections

The PWFO generates a number of performance metrics in the in-sample section. (Please see appendix II 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***) in the in-sample section will produce strategy inputs that produce statistically valid profits in the out-of-sample section. In other words we wish to find a metric ***filter*** that we can apply to the in-sample section that can give us strategy inputs that will produce, on average, good trading results in the out-of-sample sections. The PWFO produces a total of 32 different performance metrics in the in-sample section. If we have 3456 different input variations or cases then the in-sample section consists of 32 columns of performance metrics for each of the 3456 different strategy inputs or rows.

An example of a simple filter would be to choose the row in the in-sample section that had the highest net profit or perhaps a row that had one the best performance metric from one of the other 32 PWFO metrics. Unfortunately it was found that this type of simple filter very rarely produces good out-of-sample results. More complicated metric filters can produce good out-of-sample results minimizing spurious price movement biases in the selection of strategy inputs.

Here is a combination ***filter*** that is used in this paper with good out-of-sample results. High profit factors (**PF**) in the in-sample section usually mean poor performance in the out-of-sample-section. This is a kind of reversion to the mean. So in the in-sample section we eliminate all strategy input rows that have a **PF>3** . The PWFO generates the metric **nT.** This metric is the **number of Trades in the In-Sample Section**. Let us choose the 50 rows in the in-sample section that contain the lowest(bottom) number of trades from the rows that are left from the **PF** elimination. This particular filter will now leave 50 cases or rows in the in-sample section that satisfy the above filter conditions. Suppose for this filter, within the 50 in-sample rows that are left, we want the row that has the maximum PWFO metric **eq2b1** in the in-sample section**. eq2b1 = Slope(b1) of the In-Sample Equity Curve fit by a Least Squares 2nd Order Polynomial Line (b_0+ b_1*i +b_2*i$^{2)}$ to the in-sample equity curve.** This would produce a filter named **b50nT |p<3-eq2b1.** This in-sample filter leaves only one row in the PWFO in-sample section with its associated strategy inputs and out-of-sample net profit in the out-of-sample section. This particular **b50nT |p<3-eq2b1** filter finds the strategy inputs parameters in each of the 439 in-sample sections and applies these inputs to each of the 439 out-of-sample sections. Using the filter in-sample strategy inputs on the 439 out-of-sample sections, the average out-of-sample performance is calculated. In addition many other important out-of-sample performance statistics for this filter are calculated and summarized. **Figure 3** shows such a filter computer run along with a small sample of other filter combinations that are constructed in a similar manner. **Row 7** of the sample output in **Figure 3** shows the results of the filter discussed above. A total of 28830 different metric filters were examined. We chose **Row 7** because it had a lower **BE**, **BLW** and **Dev^2** and a higher **eqR2** along with better statistics than the rows above it. More on this below and on how that number of filters combinations effect the probability that the filter chosen was or was not due to chance

Bootstrap Probability of Filter Results: Using modern "Bootstrap" techniques, we can calculate the probability of obtaining each filter's total out-of-sample ***net*** profits by chance. By ***net*** we mean subtracting the cost and slippage of all round trip trades from the total out-of-sample profits. Here is how the bootstrap technique is applied. Suppose as an example, we calculate the total out-of-sample net profits(tOnpNet) over all out-of-sample weeks for a given filter like above. A mirror filter is created. However, instead of picking an out-of-sample net profit(OSNP) from a row that the filter picks, the mirror filter picks a ***random*** row's OSNP in each of the 439 PWFO files. Suppose we repeat this random row section 5000 times. Each of the 5000 mirror filters will choose a random row's OSNP of their own in each of the 439 PWFO files. At the end, each of the 5000 mirror filters will have 439 ***random*** OSNP's picked from the rows of the 439 PWFO files. The sum of the 439 random OSNP picks for each of the 5000 mirror filters will generate a random total out-of-sample net profit(tOnpNet). The average and standard deviation of the 5000 mirror filter's different random tOnpNets will allow us to calculate the chance probability for each of ***our*** filter's tOnpNet. Thus given the mirror filter's bootstrap random tOnpNet average and standard deviation, we can calculate the probability of obtaining our filter's tOnpNet by pure chance alone. Since for this run we examined 28830(shown in Figure 3) different filters, we can calculate the expected number of cases that we could obtain by pure chance that would match or exceed the tOnpNet of the filter we have chosen or (28830) X (tOnpNet Probability). For our filter in row 7 in Figure 3 the expected number of cases that we could obtain by pure chance that would match or exceed the tOnpNet of $56,292 of Row 7 is 28830 x 4.36 10^{-7} = 0.012. This is much less than one case so it is improbable that our result was due to pure chance.

Results

Table 1 on page 8 below presents a table of the 439 in-sample and out-of-sample windows, the selected optimum parameters and the weekly out-of-sample results using the filter described above.

Figure 1 presents a graph of the equity and net equity curves generated by using the filter on the 439 weeks ending 1/4/08 to 5/27/16. The equity curves are plotted from the Equity and Net Equity columns in Table 1. Plotted on the equity curves are 2nd Order Polynomial fits. The blue line is the equity curve without commissions and the red dots on the blue line are new highs in equity. The brown line is the net equity curve with commissions and the green dots are the new highs in net equity. The grey line is the weekly EC prices superimposed on the equity chart.

Figure 2 Walk Forward Out-Of-Sample Performance for EC Fading Memory Polynomial Velocity System
1 minute bar chart of EC from 12/4/15-12/4/2015

Figure 3 Partial output of the Walk Forward Metric Performance Explorer (WFME)
Run on the 439 PWFO files of the EC 1min bars Nth Order Fading Memory Velocity System

Discussion of System Performance

In Figure 3 Row 7 of the spreadsheet filter output are some statistics that are of interest for our filter. **BE** is the break even weeks. Assuming the trade average and standard deviation for this filter are from a normal distribution, this is how many weeks we need to trade this strategy so that we have a 98% probability that the equity paths after that number of weeks will be greater than zero. BE is 45.8 weeks for this filter. This means we would have to trade this strategy for at least 45.8 weeks to have a 98% probability that our equity would be positive. Another interesting statistic is **Blw**. Blw is the maximum number of weeks the OSNP equity curve failed to make a new high. Blw is 28 weeks for this filter. This means that 28 weeks was the longest time that the equity for this strategy failed to make a new equity high.

To see the effect of walk forward analysis, take a look at **Table 1**. Notice how the input parameters ***pw, N, vup and vdn*** take sudden jumps from high to low and back. This is the walk forward process quickly adapting to changing volatility conditions in the in-sample sample. In addition, notice how often ***degree*** changes from a straight line velocity with ***degree=1*** to a 2nd, 3rd and 4th order velocity with ***degree= 2, 3 and 4***. The 3rd and 4th order velocities, due to the higher order components, change much faster than the straight line velocity. When the data gets very noisy with a lot of spurious price movements, it's better to have the velocity change slower filtering out the noisy data. During other times when the noise level is not as much it is better to have the velocity break its ***vup*** and ***vdn*** barriers faster to get onboard a trend faster. This is what the filter is doing. When there is a lot of noise in the in-sample section it switches to the 1st or 2nd order curve velocity. When the noise level is lower in the in-sample section, it switches to the faster changing 3rd or 4th order curve velocity.

Using this filter, the strategy was able to generate $56,292 net equity after commissions and slippage trading one EC contract for 439 weeks. Note $20 roundtrip commission and slippage was subtracted from each trade and no positions were carried overnight. The largest losing week was -$2175 and the largest drawdown was -$4013. The longest time between new equity highs was 28 weeks.

In observing Table 1 we can see that this strategy and filter made trades from a low of no trades/week to a high of 18 trades/week with an average of 1.8 trades/week on the weeks it did trade. The strategy seemed to wait for really strong trends and then initiate a buy or sell. There were many weeks that had no trades. Out of the 439 out-of-sample weeks the filter only traded 240 of those weeks or 55% of the time with 60% of all oos weeks profitable. In observing the Equity Curve plot in Figure 1 we can see that the equity did quite well in both big up and down moves of the EC. In observing the chart from 12/3/2015 we can see the strategy trading mostly only when there is a big trend action.

Given 24 hour trading of the Euro, restricting the strategy to trade only from 7am to 1:50pm caused the strategy to miss many profitable trends opportunities when Asia and then Europe opened trading in the early morning. Further research will include the A.M. time zones.

References

1. Efron, B., Tibshirani, R.J., (1993), "An Introduction to the Bootstrap", New York, Chapman & Hall/CRC.

2. Morrison, Norman “Introduction to Sequential Smoothing and Prediction", McGraw-Hill Book Company, New York, 1969.

Figure 1 Graph of Net Equity Curve Applying the Walk Forward Filter Each Week On EC 1min Bar Prices 01/04/08 – 05/27/16

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

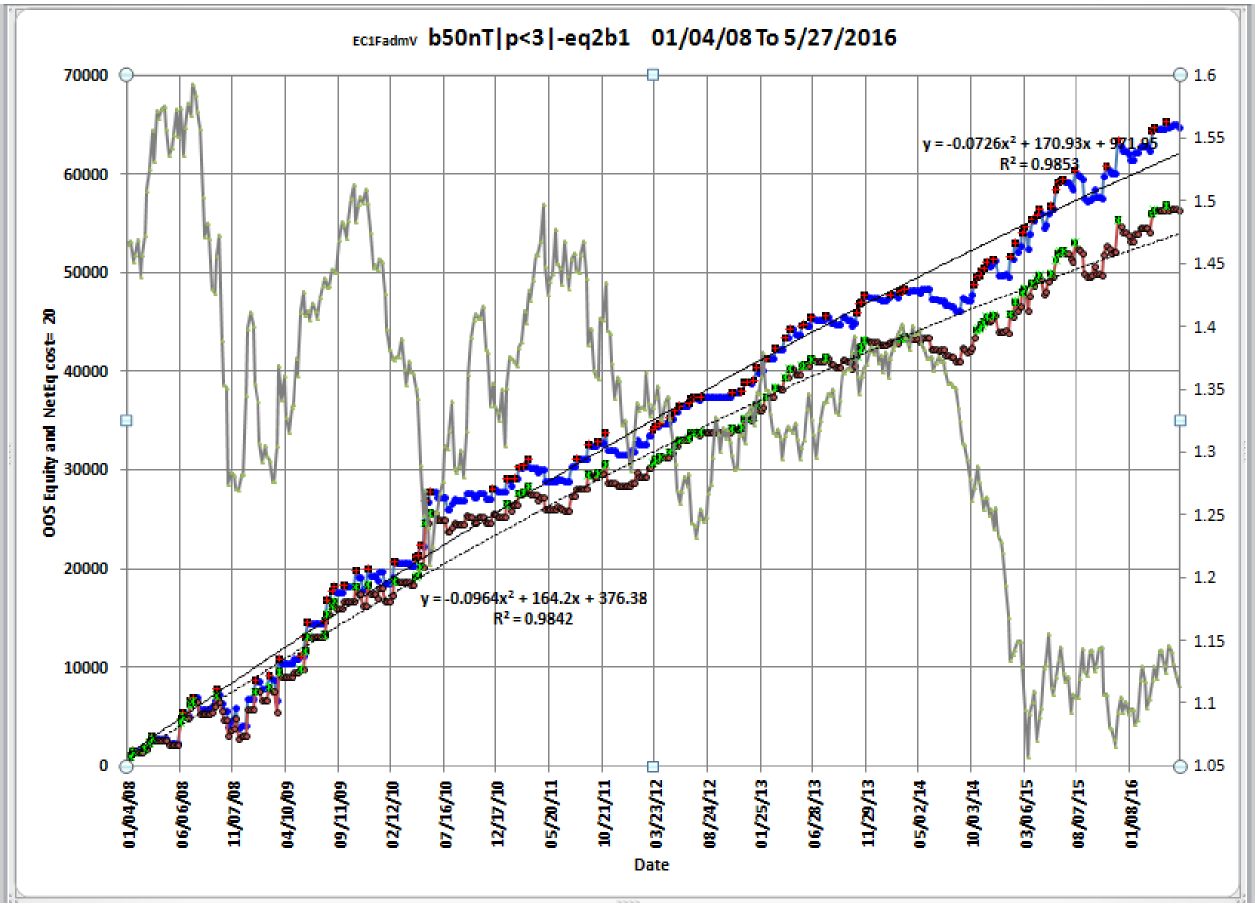


Figure 2 Walk Forward Out-Of-Sample Performance for EC Fading Memory Polynomial Velocity System
1 minute bar chart of EC from 12/3/16-12/4/16

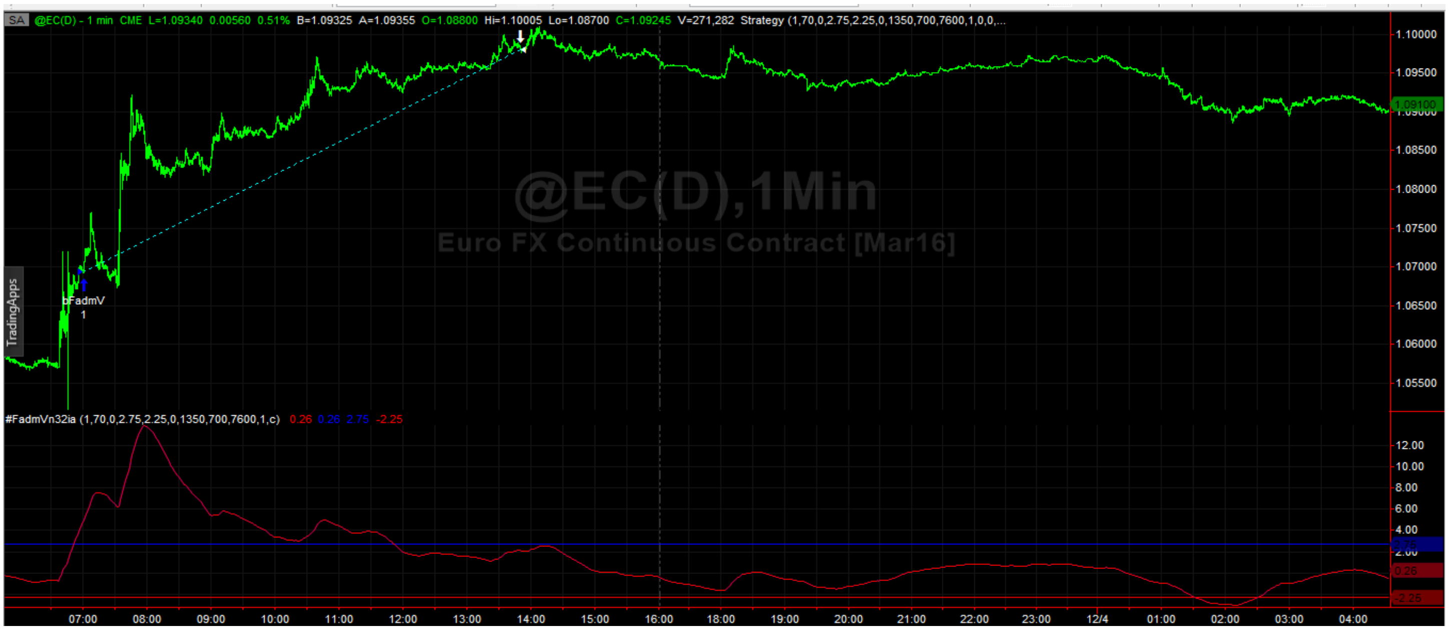
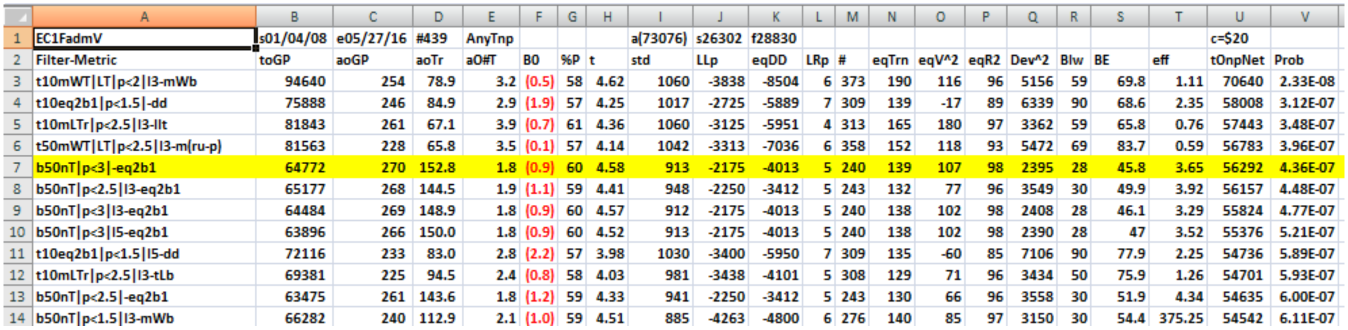


Figure 3_ Partial output of the Walk Forward Metric Performance Explorer (WFME)
EC1 min bars Nth Order Fading Memory Velocity System



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	EC1FadmV	s01/04/08	e05/27/16	#439	AnyTnp				a(73076)	s26302	f28830										c=$20	
2	Filter-Metric	toGP	aoGP	aoTr	aO#T	B0	%P	t	std	LLp	eqDD	LRp	#	eqTrn	eqV^2	eqR2	Dev^2	Blw	BE	eff	tOnpNet	Prob
3	t10mWT|LT|p<2|l3-mWb	94640	254	78.9	3.2	(0.5)	58	4.62	1060	-3838	-8504	6	373	190	116	96	5156	59	69.8	1.11	70640	2.33E-08
4	t10eq2b1|p<1.5|-dd	75888	246	84.9	2.9	(1.9)	57	4.25	1017	-2725	-5889	7	309	139	-17	89	6339	90	68.6	2.35	58008	3.12E-07
5	t10mLTr|p<2.5|l3-llt	81843	261	67.1	3.9	(0.7)	61	4.36	1060	-3125	-5951	4	313	165	180	97	3362	59	65.8	0.76	57443	3.48E-07
6	t50mWT|LT|p<2.5|l3-m(ru-p)	81563	228	65.8	3.5	(0.1)	57	4.14	1042	-3313	-7036	6	358	152	118	93	5472	69	83.7	0.59	56783	3.96E-07
7	b50nT|p<3|-eq2b1	64772	270	152.8	1.8	(0.9)	60	4.58	913	-2175	-4013	5	240	139	107	98	2395	28	45.8	3.65	56292	4.36E-07
8	b50nT|p<2.5|l3-eq2b1	65177	268	144.5	1.9	(1.1)	59	4.41	948	-2250	-3412	5	243	132	77	96	3549	30	49.9	3.92	56157	4.48E-07
9	b50nT|p<3|l3-eq2b1	64484	269	148.9	1.8	(0.9)	60	4.57	912	-2175	-4013	5	240	138	102	98	2408	28	46.1	3.29	55824	4.77E-07
10	b50nT|p<3|l5-eq2b1	63896	266	150.0	1.8	(0.9)	60	4.52	913	-2175	-4013	5	240	138	102	98	2390	28	47	3.52	55376	5.21E-07
11	t10eq2b1|p<1.5|l5-dd	72116	233	83.0	2.8	(2.2)	57	3.98	1030	-3400	-5950	7	309	135	-60	85	7106	90	77.9	2.25	54736	5.89E-07
12	t10mLTr|p<2.5|l3-tLb	69381	225	94.5	2.4	(0.8)	58	4.03	981	-3438	-4101	5	308	129	71	96	3434	50	75.9	1.26	54701	5.93E-07
13	b50nT|p<2.5|-eq2b1	63475	261	143.6	1.8	(1.2)	59	4.33	941	-2250	-3412	5	243	130	66	96	3558	30	51.9	4.34	54635	6.00E-07
14	b50nT|p<1.5|l3-mWb	66282	240	112.9	2.1	(1.0)	59	4.51	885	-4263	-4800	6	276	140	85	97	3150	30	54.4	375.25	54542	6.11E-07

The WFME Filter Output Columns are defined as follows:

Row 1 EC1FadmV is the strategy abbreviation, First OOS Week End Date(1/4/08), Last OOS Week End Date(05/27/16), **Number of weeks**(#439) **a**=average of bootstrap random picks. **s**= standard deviation of bootstrap random picks. **f**=number of different filters examined. **c**= slippage and round trip trade cost(c=$20).

Filter = The filter that was run. Row10 filter **b50nT|p<3-eq2b1**

The b50nT|p<3-eq2b1filter produced the following average 439 week statistics on Row 7.

tOnp = Total out-of-sample(oos) net profit for these 439 weeks.

aOsp = Average oos net profit for the 439 weeks

aOTrd = Average oos profit per trade

aO#T = Average number of oos trades per week

B0 = The 439 week trend of the out-of-sample weekly profits

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

t = The student t statistic for the 439 weekly oos profits. The higher the t statistic the higher the probability that this result was not due to pure chance

std = The standard deviation of the 439 weekly oos profits

llp = The largest losing oos period(week)

eqDD = The oos equity drawdown

lr = The largest number of losing oos weeks in a row

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

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

eqV^2 = The ending velocity of 2nd order polynomial that is fit to the equity curve

eqR2 = The correlation coefficient(r^2) of a straight line fit to the equity curve

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

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

tOnpNet = Total out-of-sample net profit(tOnpNet) minus the total trade cost.
tOnpNet=tOnp – (Number of trade weeks)*aOnT*Cost.

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

Table 1 Walk Forward Out-Of-Sample Performance Summary for EC Nth Order Fading Memory Polynomial Velocity System

EC-1 min bars 1/2/2008 - 05/27/2016. The input values *degree(pw), N, vup, vdn* are the values found from applying the filter to the in-sample section optimization runs.

Filter= b50nT |p<3-eq2b1 PF<=3 and Bottom 50 nT and then maximum eq2b1

osnp = Weekly Out-of-sample gross profit in $
Equity = Running Sum of weekly out-of-sample gross profits $
NOnp$20 = Weekly Out-Of-Sample Net Profit in $ = **osnp-ont*20**.
NetEq = running sum of the weekly out-of-sample net profits in $
ollt = The largest losing trade in the out-of-sample section in $.
odd = The drawdown in the out-of-sample section in $.
ont = The number of trades in the out-of-sample week.
pw= degree, degree=1 for straight line velocity, degree=2 for 2^{nd} order velocity, etc.
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	Eq	NOnp$20	NetEq	ont	ollt	odd	pw	N	vup	vdn
11/29/07	to	12/28/07	12/31/07	to	01/04/08	238	238	198	198	2	-400	-400	1	70	0.5	0.5
12/06/07	to	01/04/08	01/07/08	to	01/11/08	738	976	718	916	1	0	0	2	60	1	1.5
12/13/07	to	01/11/08	01/14/08	to	01/18/08	563	1,539	543	1,459	1	0	0	1	20	1.25	1.75
12/20/07	to	01/18/08	01/21/08	to	01/25/08		1,539		1,459				1	60	1	0.75
12/27/07	to	01/25/08	01/28/08	to	02/01/08	(13)	1,526	(33)	1,426	1	0	0	1	60	1	0.75
01/03/08	to	02/01/08	02/04/08	to	02/08/08		1,526		1,426				2	70	1.5	1.25
01/10/08	to	02/08/08	02/11/08	to	02/15/08		1,526		1,426				2	70	1.25	1.25
01/17/08	to	02/15/08	02/18/08	to	02/22/08	313	1,839	293	1,719	1	0	0	3	70	1	2
01/24/08	to	02/22/08	02/25/08	to	02/29/08		1,839		1,719				2	70	1	1.25
01/31/08	to	02/29/08	03/03/08	to	03/07/08	613	2,452	573	2,292	2	0	0	1	20	1.5	0.75
02/07/08	to	03/07/08	03/10/08	to	03/14/08	488	2,940	448	2,740	2	0	0	1	60	0.5	0.75
02/14/08	to	03/14/08	03/17/08	to	03/21/08	(138)	2,802	(158)	2,582	1	0	0	2	30	3	2.25
02/21/08	to	03/21/08	03/24/08	to	03/28/08		2,802		2,582				2	30	3	2.5
02/28/08	to	03/28/08	03/31/08	to	04/04/08		2,802		2,582				2	30	3	2.5
03/06/08	to	04/04/08	04/07/08	to	04/11/08		2,802		2,582				2	30	3	2.5
03/13/08	to	04/11/08	04/14/08	to	04/18/08		2,802		2,582				1	30	1	1.25
03/20/08	to	04/18/08	04/21/08	to	04/25/08		2,802		2,582				4	70	2.5	2.25
03/27/08	to	04/25/08	04/28/08	to	05/02/08	(475)	2,327	(495)	2,087	1	0	0	4	70	2.5	2.25
04/03/08	to	05/02/08	05/05/08	to	05/09/08		2,327		2,087				2	30	2	3
04/10/08	to	05/09/08	05/12/08	to	05/16/08		2,327		2,087				4	60	2.25	2.75
04/17/08	to	05/16/08	05/19/08	to	05/23/08		2,327		2,087				4	60	2.25	2.75
04/24/08	to	05/23/08	05/26/08	to	05/30/08		2,327		2,087				2	40	1.5	1.75
05/01/08	to	05/30/08	06/02/08	to	06/06/08	2,413	4,740	2,353	4,440	3	-175	-175	1	70	0.5	0.75
05/08/08	to	06/06/08	06/09/08	to	06/13/08	588	5,328	568	5,008	1	0	0	1	70	1.25	0.5
05/15/08	to	06/13/08	06/16/08	to	06/20/08		5,328		5,008				3	50	2	2.25
05/22/08	to	06/20/08	06/23/08	to	06/27/08	(163)	5,165	(203)	4,805	2	-488	-488	2	50	1	3
05/29/08	to	06/27/08	06/30/08	to	07/04/08	1,438	6,603	1,418	6,223	1	0	0	3	60	1.5	2
06/05/08	to	07/04/08	07/07/08	to	07/11/08	288	6,891	228	6,451	3	-50	-50	2	50	1	2.75
06/12/08	to	07/11/08	07/14/08	to	07/18/08		6,891		6,451				3	30	3	2.75
06/19/08	to	07/18/08	07/21/08	to	07/25/08		6,891		6,451				3	50	2	2.5

In-Sample Dates			Out-Of_Sample Dates			osnp	Eq	NOnp$20	NetEq	ont	ollt	odd	pw	N	vup	vdn
06/26/08	to	07/25/08	07/28/08	to	08/01/08	(1,075)	5,816	(1,135)	5,316	3	-1050	-1500	3	30	3	2.75
07/03/08	to	08/01/08	08/04/08	to	08/08/08		5,816		5,316				3	50	2.25	2.5
07/10/08	to	08/08/08	08/11/08	to	08/15/08		5,816		5,316				2	30	2.25	2.25
07/17/08	to	08/15/08	08/18/08	to	08/22/08		5,816		5,316				2	30	2	2.25
07/24/08	to	08/22/08	08/25/08	to	08/29/08		5,816		5,316				2	30	2	2.25
07/31/08	to	08/29/08	09/01/08	to	09/05/08	225	6,041	205	5,521	1	0	0	2	40	2	1.5
08/07/08	to	09/05/08	09/08/08	to	09/12/08	613	6,654	573	6,094	2	0	0	4	50	2.75	2.25
08/14/08	to	09/12/08	09/15/08	to	09/19/08	1,113	7,767	1,013	7,107	5	-1413	-1525	3	30	3	2.5
08/21/08	to	09/19/08	09/22/08	to	09/26/08	(563)	7,204	(603)	6,504	2	-1013	-1013	1	40	1.75	0.75
08/28/08	to	09/26/08	09/29/08	to	10/03/08	(863)	6,341	(963)	5,541	5	-1275	-1275	2	50	2.5	1.25
09/04/08	to	10/03/08	10/06/08	to	10/10/08	(663)	5,678	(763)	4,778	5	-1563	-3488	1	30	1.5	1
09/11/08	to	10/10/08	10/13/08	to	10/17/08		5,678		4,778				3	70	2.75	3
09/18/08	to	10/17/08	10/20/08	to	10/24/08	(1,750)	3,928	(1,770)	3,008	1	0	0	1	20	2	2.75
09/25/08	to	10/24/08	10/27/08	to	10/31/08	688	4,616	648	3,656	2	0	0	2	50	1.5	3
10/02/08	to	10/31/08	11/03/08	to	11/07/08	213	4,829	153	3,809	3	-150	-150	4	70	3	3
10/09/08	to	11/07/08	11/10/08	to	11/14/08	1,050	5,879	1,030	4,839	1	0	0	1	50	2	1
10/16/08	to	11/14/08	11/17/08	to	11/21/08	(2,125)	3,754	(2,145)	2,694	1	0	0	1	30	1.75	2
10/23/08	to	11/21/08	11/24/08	to	11/28/08	400	4,154	380	3,074	1	0	0	1	30	1.75	2
10/30/08	to	11/28/08	12/01/08	to	12/05/08		4,154		3,074				2	70	3	1.75
11/06/08	to	12/05/08	12/08/08	to	12/12/08		4,154		3,074				2	70	3	1.75
11/13/08	to	12/12/08	12/15/08	to	12/19/08	2,675	6,829	2,635	5,709	2	-175	-175	1	30	3	1.25
11/20/08	to	12/19/08	12/22/08	to	12/26/08		6,829		5,709				1	40	2	2.5
11/27/08	to	12/26/08	12/29/08	to	01/02/09		6,829		5,709				2	50	2.25	3
12/04/08	to	01/02/09	01/05/09	to	01/09/09	1,800	8,629	1,780	7,489	1	0	0	1	60	2.5	1
12/11/08	to	01/09/09	01/12/09	to	01/16/09		8,629		7,489				2	70	2	2.75
12/18/08	to	01/16/09	01/19/09	to	01/23/09		8,629		7,489				1	20	2.75	3
12/25/08	to	01/23/09	01/26/09	to	01/30/09	(775)	7,854	(835)	6,654	3	-400	-775	2	50	2.75	2
01/01/09	to	01/30/09	02/02/09	to	02/06/09		7,854		6,654				1	30	2.25	1.75
01/08/09	to	02/06/09	02/09/09	to	02/13/09		7,854		6,654				2	40	3	3
01/15/09	to	02/13/09	02/16/09	to	02/20/09	1,313	9,167	1,293	7,947	1	0	0	2	40	2	2.75
01/22/09	to	02/20/09	02/23/09	to	02/27/09	(363)	8,804	(383)	7,564	1	0	0	2	40	2	2.75
01/29/09	to	02/27/09	03/02/09	to	03/06/09		8,804		7,564				1	30	3	1.25
02/05/09	to	03/06/09	03/09/09	to	03/13/09	(2,138)	6,666	(2,158)	5,406	1	0	0	2	30	2.75	3
02/12/09	to	03/13/09	03/16/09	to	03/20/09	4,175	10,841	4,135	9,541	2	0	0	1	60	0.75	1
02/19/09	to	03/20/09	03/23/09	to	03/27/09	(438)	10,403	(458)	9,083	1	0	0	1	20	2	2
02/26/09	to	03/27/09	03/30/09	to	04/03/09		10,403		9,083				1	20	3	2
03/05/09	to	04/03/09	04/06/09	to	04/10/09		10,403		9,083				1	20	3	2
03/12/09	to	04/10/09	04/13/09	to	04/17/09		10,403		9,083				1	20	3	1.75
03/19/09	to	04/17/09	04/20/09	to	04/24/09		10,403		9,083				1	30	1.5	1.5
03/26/09	to	04/24/09	04/27/09	to	05/01/09	413	10,816	393	9,476	1	0	0	1	30	1.25	1.25
04/02/09	to	05/01/09	05/04/09	to	05/08/09		10,816		9,476				1	60	1	0.75
04/09/09	to	05/08/09	05/11/09	to	05/15/09		10,816		9,476				4	70	3	2.25
04/16/09	to	05/15/09	05/18/09	to	05/22/09	338	11,154	298	9,774	2	0	0	3	70	2	1.75
04/23/09	to	05/22/09	05/25/09	to	05/29/09		11,154		9,774				2	60	2	1.25
04/30/09	to	05/29/09	06/01/09	to	06/05/09	1,913	13,067	1,893	11,667	1	0	0	4	60	3	2.5
05/07/09	to	06/05/09	06/08/09	to	06/12/09	1,463	14,530	1,443	13,110	1	0	0	1	40	1	2
05/14/09	to	06/12/09	06/15/09	to	06/19/09		14,530		13,110				1	20	1.75	3
05/21/09	to	06/19/09	06/22/09	to	06/26/09		14,530		13,110				1	20	1.75	3
05/28/09	to	06/26/09	06/29/09	to	07/03/09		14,530		13,110				1	50	0.75	1.75

In-Sample Dates			Out-Of_Sample Dates			osnp	Eq	NOnp$20	NetEq	ont	ollt	odd	pw	N	vup	vdn
06/04/09	to	07/03/09	07/06/09	to	07/10/09		14,530		13,110				1	50	0.75	1.75
06/11/09	to	07/10/09	07/13/09	to	07/17/09		14,530		13,110				4	50	3	2.25
06/18/09	to	07/17/09	07/20/09	to	07/24/09		14,530		13,110				4	50	3	2.25
06/25/09	to	07/24/09	07/27/09	to	07/31/09	213	14,743	193	13,303	1	0	0	4	50	2	2.75
07/02/09	to	07/31/09	08/03/09	to	08/07/09	2,075	16,818	2,035	15,338	2	0	0	4	50	2.5	2
07/09/09	to	08/07/09	08/10/09	to	08/14/09		16,818		15,338				1	50	0.75	1
07/16/09	to	08/14/09	08/17/09	to	08/21/09	900	17,718	880	16,218	1	0	0	1	30	0.75	1.5
07/23/09	to	08/21/09	08/24/09	to	08/28/09	500	18,218	480	16,698	1	0	0	2	30	2.25	2.25
07/30/09	to	08/28/09	08/31/09	to	09/04/09	(663)	17,555	(703)	15,995	2	-1375	-1375	2	50	2.25	1.25
08/06/09	to	09/04/09	09/07/09	to	09/11/09		17,555		15,995				1	70	0.75	0.75
08/13/09	to	09/11/09	09/14/09	to	09/18/09		17,555		15,995				3	70	3	1.5
08/20/09	to	09/18/09	09/21/09	to	09/25/09	713	18,268	693	16,688	1	0	0	3	70	3	1.5
08/27/09	to	09/25/09	09/28/09	to	10/02/09		18,268		16,688				1	30	2	1
09/03/09	to	10/02/09	10/05/09	to	10/09/09		18,268		16,688				3	60	1.75	2
09/10/09	to	10/09/09	10/12/09	to	10/16/09		18,268		16,688				1	60	1	0.5
09/17/09	to	10/16/09	10/19/09	to	10/23/09		18,268		16,688				1	60	1	0.5
09/24/09	to	10/23/09	10/26/09	to	10/30/09	1,500	19,768	1,460	18,148	2	0	0	1	60	1	0.5
10/01/09	to	10/30/09	11/02/09	to	11/06/09	(700)	19,068	(720)	17,428	1	0	0	2	30	2	2
10/08/09	to	11/06/09	11/09/09	to	11/13/09		19,068		17,428				4	60	2	2.5
10/15/09	to	11/13/09	11/16/09	to	11/20/09	(1,138)	17,930	(1,158)	16,270	1	0	0	4	60	2	2.5
10/22/09	to	11/20/09	11/23/09	to	11/27/09		17,930		16,270				4	60	2	3
10/29/09	to	11/27/09	11/30/09	to	12/04/09	2,063	19,993	2,043	18,313	1	0	0	4	60	2	3
11/05/09	to	12/04/09	12/07/09	to	12/11/09	(763)	19,230	(783)	17,530	1	0	0	1	50	0.5	1.5
11/12/09	to	12/11/09	12/14/09	to	12/18/09		19,230		17,530				3	50	1.75	3
11/18/09	to	12/17/09	12/20/09	to	12/24/09		19,230		17,530				3	50	1.75	3
11/25/09	to	12/24/09	12/27/09	to	12/31/09	(413)	18,817	(453)	17,077	2	-338	-413	2	20	1.75	2.75
12/03/09	to	01/01/10	01/04/10	to	01/08/10	975	19,792	955	18,032	1	0	0	3	50	1.75	3
12/10/09	to	01/08/10	01/11/10	to	01/15/10		19,792		18,032				2	50	2.75	1.5
12/17/09	to	01/15/10	01/18/10	to	01/22/10	(1,300)	18,492	(1,360)	16,672	3	-838	-1300	3	40	2	1.75
12/24/09	to	01/22/10	01/25/10	to	01/29/10		18,492		16,672				1	30	2	1
12/31/09	to	01/29/10	02/01/10	to	02/05/10		18,492		16,672				1	50	0.75	0.75
01/07/10	to	02/05/10	02/08/10	to	02/12/10	663	19,155	603	17,275	3	-13	-13	2	40	1	2
01/14/10	to	02/12/10	02/15/10	to	02/19/10	1,500	20,655	1,440	18,715	3	0	0	2	30	1.25	2.25
01/21/10	to	02/19/10	02/22/10	to	02/26/10		20,655		18,715				3	40	2.5	3
01/28/10	to	02/26/10	03/01/10	to	03/05/10		20,655		18,715				3	40	2.5	2.75
02/04/10	to	03/05/10	03/08/10	to	03/12/10		20,655		18,715				3	30	3	3
02/11/10	to	03/12/10	03/15/10	to	03/19/10	(75)	20,580	(95)	18,620	1	0	0	3	60	2	1.25
02/18/10	to	03/19/10	03/22/10	to	03/26/10		20,580		18,620				1	70	0.75	0.5
02/25/10	to	03/26/10	03/29/10	to	04/02/10		20,580		18,620				1	70	0.75	0.5
03/04/10	to	04/02/10	04/05/10	to	04/09/10	(188)	20,392	(208)	18,412	1	0	0	1	70	0.5	0.5
03/11/10	to	04/09/10	04/12/10	to	04/16/10		20,392		18,412				4	50	3	2
03/18/10	to	04/16/10	04/19/10	to	04/23/10	725	21,117	705	19,117	1	0	0	3	70	1	1.75
03/25/10	to	04/23/10	04/26/10	to	04/30/10	225	21,342	165	19,282	3	-513	-513	1	40	1	0.5
04/01/10	to	04/30/10	05/03/10	to	05/07/10	988	22,330	928	20,210	3	-113	-113	3	60	2	1.5
04/08/10	to	05/07/10	05/10/10	to	05/14/10		22,330		20,210				3	70	1.5	2.25
04/15/10	to	05/14/10	05/17/10	to	05/21/10	4,475	26,805	4,395	24,605	4	-75	-75	1	40	0.5	1.5
04/22/10	to	05/21/10	05/24/10	to	05/28/10		26,805		24,605				2	60	2.5	1.5
04/29/10	to	05/28/10	05/31/10	to	06/04/10	1,013	27,818	993	25,598	1	0	0	1	70	1.25	0.5
05/06/10	to	06/04/10	06/07/10	to	06/11/10		27,818		25,598				1	30	1.5	1.75

In-Sample Dates			Out-Of_Sample Dates			osnp	Eq	NOnp$20	NetEq	ont	ollt	odd	pw	N	vup	vdn
05/13/10	to	06/11/10	06/14/10	to	06/18/10		27,818		25,598				4	70	2	2.75
05/20/10	to	06/18/10	06/21/10	to	06/25/10	(650)	27,168	(670)	24,928	1	0	0	4	70	2	2.75
05/27/10	to	06/25/10	06/28/10	to	07/02/10		27,168		24,928				2	70	1.25	1.75
06/03/10	to	07/02/10	07/05/10	to	07/09/10		27,168		24,928				2	70	1	1
06/10/10	to	07/09/10	07/12/10	to	07/16/10		27,168		24,928				3	40	2.5	1.75
06/17/10	to	07/16/10	07/19/10	to	07/23/10	(1,088)	26,080	(1,128)	23,800	2	-1288	-1288	4	40	3	2
06/24/10	to	07/23/10	07/26/10	to	07/30/10		26,080		23,800				4	60	2.5	2.25
07/01/10	to	07/30/10	08/02/10	to	08/06/10	513	26,593	493	24,293	1	0	0	2	50	1.25	1.5
07/08/10	to	08/06/10	08/09/10	to	08/13/10	450	27,043	430	24,723	1	0	0	2	20	3	3
07/15/10	to	08/13/10	08/16/10	to	08/20/10	(138)	26,905	(158)	24,565	1	0	0	2	40	3	1.5
07/22/10	to	08/20/10	08/23/10	to	08/27/10		26,905		24,565				2	70	1.5	1.5
07/29/10	to	08/27/10	08/30/10	to	09/03/10		26,905		24,565				2	20	3	2.75
08/05/10	to	09/03/10	09/06/10	to	09/10/10		26,905		24,565				2	20	3	2.75
08/12/10	to	09/10/10	09/13/10	to	09/17/10	825	27,730	805	25,370	1	0	0	2	20	3	2.25
08/19/10	to	09/17/10	09/20/10	to	09/24/10	(125)	27,605	(145)	25,225	1	0	0	1	60	1	0.5
08/26/10	to	09/24/10	09/27/10	to	10/01/10		27,605		25,225				1	70	0.75	0.5
09/02/10	to	10/01/10	10/04/10	to	10/08/10	(450)	27,155	(490)	24,735	2	-588	-588	1	60	0.5	0.5
09/09/10	to	10/08/10	10/11/10	to	10/15/10		27,155		24,735				1	20	1.75	2
09/16/10	to	10/15/10	10/18/10	to	10/22/10	563	27,718	543	25,278	1	0	0	2	50	1.5	1.5
09/23/10	to	10/22/10	10/25/10	to	10/29/10		27,718		25,278				4	60	2.75	3
09/30/10	to	10/29/10	11/01/10	to	11/05/10		27,718		25,278				3	70	2	1.5
10/07/10	to	11/05/10	11/08/10	to	11/12/10	(600)	27,118	(620)	24,658	1	0	0	3	70	2	1.5
10/14/10	to	11/12/10	11/15/10	to	11/19/10		27,118		24,658				3	60	2	1.75
10/21/10	to	11/19/10	11/22/10	to	11/26/10		27,118		24,658				3	70	1.25	2.25
10/28/10	to	11/26/10	11/29/10	to	12/03/10	950	28,068	890	25,548	3	-338	-338	3	70	1.25	2.25
11/04/10	to	12/03/10	12/06/10	to	12/10/10		28,068		25,548				3	60	2.25	2.75
11/11/10	to	12/10/10	12/13/10	to	12/17/10	(313)	27,755	(333)	25,215	1	0	0	1	40	1.25	0.75
11/18/10	to	12/17/10	12/20/10	to	12/24/10		27,755		25,215				3	60	2.25	2.5
11/25/10	to	12/24/10	12/27/10	to	12/31/10		27,755		25,215				3	60	2.25	2.5
12/02/10	to	12/31/10	01/03/11	to	01/07/11		27,755		25,215				4	60	2.5	2.75
12/09/10	to	01/07/11	01/10/11	to	01/14/11	1,325	29,080	1,305	26,520	1	0	0	1	60	0.5	1
12/16/10	to	01/14/11	01/17/11	to	01/21/11		29,080		26,520				2	70	1.5	1
12/23/10	to	01/21/11	01/24/11	to	01/28/11	(588)	28,492	(608)	25,912	1	0	0	1	20	1.75	1.25
12/30/10	to	01/28/11	01/31/11	to	02/04/11	625	29,117	605	26,517	1	0	0	2	30	2	2
01/06/11	to	02/04/11	02/07/11	to	02/11/11		29,117		26,517				1	60	0.5	1
01/13/11	to	02/11/11	02/14/11	to	02/18/11	1,125	30,242	1,085	27,602	2	0	0	2	70	0.75	1.5
01/20/11	to	02/18/11	02/21/11	to	02/25/11		30,242		27,602				3	30	3	2.75
01/27/11	to	02/25/11	02/28/11	to	03/04/11	150	30,392	130	27,732	1	0	0	3	70	1	2.25
02/03/11	to	03/04/11	03/07/11	to	03/11/11		30,392		27,732				2	70	1.75	0.75
02/10/11	to	03/11/11	03/14/11	to	03/18/11	663	31,055	623	28,355	2	0	0	3	70	1	1.25
02/17/11	to	03/18/11	03/21/11	to	03/25/11	(750)	30,305	(810)	27,545	3	-1050	-1050	2	40	1	1.25
02/24/11	to	03/25/11	03/28/11	to	04/01/11		30,305		27,545				2	20	2.5	2.75
03/03/11	to	04/01/11	04/04/11	to	04/08/11		30,305		27,545				2	20	2.5	2.75
03/10/11	to	04/08/11	04/11/11	to	04/15/11	(525)	29,780	(545)	27,000	1	0	0	1	30	1	0.75
03/17/11	to	04/15/11	04/18/11	to	04/22/11	275	30,055	255	27,255	1	0	0	3	60	1.75	1.5
03/24/11	to	04/22/11	04/25/11	to	04/29/11		30,055		27,255				4	60	1.75	2.75
03/31/11	to	04/29/11	05/02/11	to	05/06/11	(1,125)	28,930	(1,185)	26,070	3	-2938	-2938	3	50	1.5	2.75
04/07/11	to	05/06/11	05/09/11	to	05/13/11		28,930		26,070				2	40	1.75	2.25
04/14/11	to	05/13/11	05/16/11	to	05/20/11		28,930		26,070				2	40	1.75	2.25

In-Sample Dates			Out-Of_Sample Dates			osnp	Eq	NOnp$20	NetEq	ont	ollt	odd	pw	N	vup	vdn
04/21/11	to	05/20/11	05/23/11	to	05/27/11		28,930		26,070				2	40	1.75	2.25
04/28/11	to	05/27/11	05/30/11	to	06/03/11		28,930		26,070				2	40	1.75	2.25
05/05/11	to	06/03/11	06/06/11	to	06/10/11	250	29,180	230	26,300	1	0	0	2	40	1.75	2.25
05/12/11	to	06/10/11	06/13/11	to	06/17/11	(125)	29,055	(145)	26,155	1	0	0	2	50	1.25	2
05/19/11	to	06/17/11	06/20/11	to	06/24/11	(88)	28,967	(108)	26,047	1	0	0	1	70	0.5	0.75
05/26/11	to	06/24/11	06/27/11	to	07/01/11	(113)	28,854	(153)	25,894	2	-150	-150	1	70	0.5	0.75
06/02/11	to	07/01/11	07/04/11	to	07/08/11	13	28,867	(27)	25,867	2	-163	-163	1	50	1	0.5
06/09/11	to	07/08/11	07/11/11	to	07/15/11		28,867		25,867				3	60	2.25	2.25
06/16/11	to	07/15/11	07/18/11	to	07/22/11	1,500	30,367	1,480	27,347	1	0	0	2	60	1.5	1.25
06/23/11	to	07/22/11	07/25/11	to	07/29/11		30,367		27,347				2	60	2.25	1.25
06/30/11	to	07/29/11	08/01/11	to	08/05/11	763	31,130	723	28,070	2	-163	-163	1	70	1.25	0.5
07/07/11	to	08/05/11	08/08/11	to	08/12/11		31,130		28,070				1	50	1	1.25
07/14/11	to	08/12/11	08/15/11	to	08/19/11		31,130		28,070				1	50	1	1.25
07/21/11	to	08/19/11	08/22/11	to	08/26/11		31,130		28,070				1	50	1	1.25
07/28/11	to	08/26/11	08/29/11	to	09/02/11		31,130		28,070				3	70	2.5	1.75
08/04/11	to	09/02/11	09/05/11	to	09/09/11	1,475	32,605	1,435	29,505	2	0	0	2	40	2.5	1.75
08/11/11	to	09/09/11	09/12/11	to	09/16/11	(63)	32,542	(83)	29,422	1	0	0	4	70	2.5	2.75
08/18/11	to	09/16/11	09/19/11	to	09/23/11	(50)	32,492	(70)	29,352	1	0	0	3	70	2.5	2
08/25/11	to	09/23/11	09/26/11	to	09/30/11		32,492		29,352				1	50	1.25	1
09/01/11	to	09/30/11	10/03/11	to	10/07/11	313	32,805	293	29,645	1	0	0	1	50	1.25	1
09/08/11	to	10/07/11	10/10/11	to	10/14/11		32,805		29,645				1	20	2	2.5
09/15/11	to	10/14/11	10/17/11	to	10/21/11		32,805		29,645				1	20	2	2.5
09/22/11	to	10/21/11	10/24/11	to	10/28/11	938	33,743	918	30,563	1	0	0	2	70	1.25	1.75
09/29/11	to	10/28/11	10/31/11	to	11/04/11	(1,763)	31,980	(1,783)	28,780	1	0	0	1	30	1.75	1.25
10/06/11	to	11/04/11	11/07/11	to	11/11/11		31,980		28,780				2	50	2.25	1.75
10/13/11	to	11/11/11	11/14/11	to	11/18/11		31,980		28,780				1	20	1.75	1.75
10/20/11	to	11/18/11	11/21/11	to	11/25/11		31,980		28,780				1	20	1.75	1.75
10/27/11	to	11/25/11	11/28/11	to	12/02/11	(400)	31,580	(420)	28,360	1	0	0	2	70	1.25	1.5
11/03/11	to	12/02/11	12/05/11	to	12/09/11	63	31,643	43	28,403	1	0	0	4	70	2.5	2.5
11/10/11	to	12/09/11	12/12/11	to	12/16/11		31,643		28,403				1	60	0.5	1
11/17/11	to	12/16/11	12/19/11	to	12/23/11		31,643		28,403				2	40	1.5	2.75
11/24/11	to	12/23/11	12/26/11	to	12/30/11		31,643		28,403				1	20	1	2.25
12/01/11	to	12/30/11	01/02/12	to	01/06/12		31,643		28,403				2	70	0.75	1.75
12/08/11	to	01/06/12	01/09/12	to	01/13/12	388	32,031	368	28,771	1	0	0	2	70	0.75	1.75
12/15/11	to	01/13/12	01/16/12	to	01/20/12	(75)	31,956	(95)	28,676	1	0	0	4	70	1.25	2.75
12/22/11	to	01/20/12	01/23/12	to	01/27/12	1,163	33,119	1,123	29,799	2	0	0	3	70	1	2.25
12/29/11	to	01/27/12	01/30/12	to	02/03/12	(463)	32,656	(483)	29,316	1	0	0	3	40	2.75	1.75
01/05/12	to	02/03/12	02/06/12	to	02/10/12		32,656		29,316				2	30	2.25	2
01/12/12	to	02/10/12	02/13/12	to	02/17/12		32,656		29,316				2	30	2.25	2
01/19/12	to	02/17/12	02/20/12	to	02/24/12		32,656		29,316				2	20	2.75	3
01/26/12	to	02/24/12	02/27/12	to	03/02/12	888	33,544	868	30,184	1	0	0	2	30	2.25	1.5
02/02/12	to	03/02/12	03/05/12	to	03/09/12		33,544		30,184				2	20	2.75	2.5
02/09/12	to	03/09/12	03/12/12	to	03/16/12	488	34,032	468	30,652	1	0	0	2	60	1	1.5
02/16/12	to	03/16/12	03/19/12	to	03/23/12	400	34,432	380	31,032	1	0	0	2	50	1	1.5
02/23/12	to	03/23/12	03/26/12	to	03/30/12		34,432		31,032				1	50	0.75	0.5
03/01/12	to	03/30/12	04/02/12	to	04/06/12	300	34,732	280	31,312	1	0	0	2	50	1.25	1
03/08/12	to	04/06/12	04/09/12	to	04/13/12		34,732		31,312				4	40	2.5	2.5
03/15/12	to	04/13/12	04/16/12	to	04/20/12		34,732		31,312				2	70	1	1.5
03/22/12	to	04/20/12	04/23/12	to	04/27/12		34,732		31,312				4	50	2.25	1.5

In-Sample Dates			Out-Of_Sample Dates			osnp	Eq	NOnp$20	NetEq	ont	ollt	odd	pw	N	vup	vdn
03/29/12	to	04/27/12	04/30/12	to	05/04/12	525	35,257	485	31,797	2	0	0	4	50	2.25	1.5
04/05/12	to	05/04/12	05/07/12	to	05/11/12		35,257		31,797				4	30	3	3
04/12/12	to	05/11/12	05/14/12	to	05/18/12	688	35,945	668	32,465	1	0	0	3	60	1.5	1
04/19/12	to	05/18/12	05/21/12	to	05/25/12		35,945		32,465				2	20	2	2.5
04/26/12	to	05/25/12	05/28/12	to	06/01/12	575	36,520	555	33,020	1	0	0	2	20	2	2.5
05/03/12	to	06/01/12	06/04/12	to	06/08/12		36,520		33,020				4	40	2.5	2.5
05/10/12	to	06/08/12	06/11/12	to	06/15/12		36,520		33,020				4	40	2.5	2.5
05/17/12	to	06/15/12	06/18/12	to	06/22/12		36,520		33,020				4	70	2	1.75
05/24/12	to	06/22/12	06/25/12	to	06/29/12	238	36,758	218	33,238	1	0	0	2	20	2.25	3
05/31/12	to	06/29/12	07/02/12	to	07/06/12	513	37,271	493	33,731	1	0	0	4	40	3	3
06/07/12	to	07/06/12	07/09/12	to	07/13/12	50	37,321	30	33,761	1	0	0	2	70	0.75	1.5
06/14/12	to	07/13/12	07/16/12	to	07/20/12		37,321		33,761				1	60	0.5	1
06/21/12	to	07/20/12	07/23/12	to	07/27/12	(175)	37,146	(195)	33,566	1	0	0	2	70	1.5	1
06/28/12	to	07/27/12	07/30/12	to	08/03/12	275	37,421	255	33,821	1	0	0	3	70	2.25	1.75
07/05/12	to	08/03/12	08/06/12	to	08/10/12		37,421		33,821				1	70	0.5	1
07/12/12	to	08/10/12	08/13/12	to	08/17/12		37,421		33,821				1	70	0.5	1
07/19/12	to	08/17/12	08/20/12	to	08/24/12		37,421		33,821				1	70	0.75	0.5
07/26/12	to	08/24/12	08/27/12	to	08/31/12		37,421		33,821				1	70	0.75	0.5
08/02/12	to	08/31/12	09/03/12	to	09/07/12		37,421		33,821				4	40	3	2.75
08/09/12	to	09/07/12	09/10/12	to	09/14/12		37,421		33,821				3	30	2.75	1.75
08/16/12	to	09/14/12	09/17/12	to	09/21/12		37,421		33,821				1	40	0.75	0.75
08/23/12	to	09/21/12	09/24/12	to	09/28/12	(25)	37,396	(45)	33,776	1	0	0	1	40	0.75	0.75
08/30/12	to	09/28/12	10/01/12	to	10/05/12		37,396		33,776				1	40	0.75	1
09/06/12	to	10/05/12	10/08/12	to	10/12/12		37,396		33,776				1	40	0.75	1
09/13/12	to	10/12/12	10/15/12	to	10/19/12		37,396		33,776				3	20	2.5	2.5
09/20/12	to	10/19/12	10/22/12	to	10/26/12		37,396		33,776				4	30	2.25	2.25
09/27/12	to	10/26/12	10/29/12	to	11/02/12	425	37,821	405	34,181	1	0	0	4	30	2.25	2.25
10/04/12	to	11/02/12	11/05/12	to	11/09/12		37,821		34,181				2	20	1.25	2
10/11/12	to	11/09/12	11/12/12	to	11/16/12		37,821		34,181				4	20	3	2.75
10/18/12	to	11/16/12	11/19/12	to	11/23/12		37,821		34,181				4	20	3	2.75
10/25/12	to	11/23/12	11/26/12	to	11/30/12	113	37,934	93	34,274	1	0	0	4	30	2	1.75
11/01/12	to	11/30/12	12/03/12	to	12/07/12	875	38,809	855	35,129	1	0	0	2	30	1.25	1.25
11/08/12	to	12/07/12	12/10/12	to	12/14/12	63	38,872	23	35,152	2	-125	-125	4	50	1.25	2.25
11/15/12	to	12/14/12	12/17/12	to	12/21/12		38,872		35,152				2	70	0.75	0.75
11/22/12	to	12/21/12	12/24/12	to	12/28/12	(125)	38,747	(145)	35,007	1	0	0	4	40	2	1.75
11/29/12	to	12/28/12	12/31/12	to	01/04/13	338	39,085	298	35,305	2	0	0	3	60	1.5	1.25
12/06/12	to	01/04/13	01/07/13	to	01/11/13	1,325	40,410	1,285	36,590	2	0	0	2	70	0.75	1
12/13/12	to	01/11/13	01/14/13	to	01/18/13	(513)	39,897	(553)	36,037	2	-363	-513	1	30	1.5	0.75
12/20/12	to	01/18/13	01/21/13	to	01/25/13		39,897		36,037				2	30	1.5	2
12/27/12	to	01/25/13	01/28/13	to	02/01/13	300	40,197	280	36,317	1	0	0	2	30	1.25	2
01/03/13	to	02/01/13	02/04/13	to	02/08/13	1,075	41,272	1,055	37,372	1	0	0	4	70	2.25	2
01/10/13	to	02/08/13	02/11/13	to	02/15/13		41,272		37,372				1	60	0.5	1
01/17/13	to	02/15/13	02/18/13	to	02/22/13		41,272		37,372				3	40	2	3
01/24/13	to	02/22/13	02/25/13	to	03/01/13		41,272		37,372				2	30	1.5	2.75
01/31/13	to	03/01/13	03/04/13	to	03/08/13	1,013	42,285	973	38,345	2	0	0	3	40	1.25	3
02/07/13	to	03/08/13	03/11/13	to	03/15/13		42,285		38,345				1	40	0.75	1.25
02/14/13	to	03/15/13	03/18/13	to	03/22/13	(100)	42,185	(140)	38,205	2	-163	-163	3	30	2	3
02/21/13	to	03/22/13	03/25/13	to	03/29/13		42,185		38,205				2	70	0.75	1.75
02/28/13	to	03/29/13	04/01/13	to	04/05/13	1,188	43,373	1,148	39,353	2	-13	-13	2	70	0.75	1.75

In-Sample Dates			Out-Of_Sample Dates			osnp	Eq	NOnp$20	NetEq	ont	ollt	odd	pw	N	vup	vdn
03/07/13	to	04/05/13	04/08/13	to	04/12/13		43,373		39,353				2	60	1.75	1
03/14/13	to	04/12/13	04/15/13	to	04/19/13	938	44,311	918	40,271	1	0	0	3	40	3	1.25
03/21/13	to	04/19/13	04/22/13	to	04/26/13		44,311		40,271				1	20	1.75	1.5
03/28/13	to	04/26/13	04/29/13	to	05/03/13	(575)	43,736	(615)	39,656	2	-863	-863	1	70	0.75	0.5
04/04/13	to	05/03/13	05/06/13	to	05/10/13		43,736		39,656				3	50	2.5	2.5
04/11/13	to	05/10/13	05/13/13	to	05/17/13		43,736		39,656				2	20	2.75	3
04/18/13	to	05/17/13	05/20/13	to	05/24/13	900	44,636	880	40,536	1	0	0	4	60	3	2
04/25/13	to	05/24/13	05/27/13	to	05/31/13	125	44,761	105	40,641	1	0	0	1	30	1	1.25
05/02/13	to	05/31/13	06/03/13	to	06/07/13	(100)	44,661	(120)	40,521	1	0	0	1	30	1.25	1.25
05/09/13	to	06/07/13	06/10/13	to	06/14/13		44,661		40,521				1	20	1.75	1.5
05/16/13	to	06/14/13	06/17/13	to	06/21/13	750	45,411	730	41,251	1	0	0	1	20	1.75	1.5
05/23/13	to	06/21/13	06/24/13	to	06/28/13		45,411		41,251				4	50	2.5	3
05/30/13	to	06/28/13	07/01/13	to	07/05/13	(238)	45,173	(278)	40,973	2	-125	-238	4	50	2.5	3
06/06/13	to	07/05/13	07/08/13	to	07/12/13		45,173		40,973				2	70	1.25	1.25
06/13/13	to	07/12/13	07/15/13	to	07/19/13		45,173		40,973				2	70	1	1.25
06/20/13	to	07/19/13	07/22/13	to	07/26/13		45,173		40,973				2	20	2.75	2.75
06/27/13	to	07/26/13	07/29/13	to	08/02/13	425	45,598	405	41,378	1	0	0	2	20	2.75	2.75
07/04/13	to	08/02/13	08/05/13	to	08/09/13		45,598		41,378				2	50	1.5	1.5
07/11/13	to	08/09/13	08/12/13	to	08/16/13	(625)	44,973	(665)	40,713	2	-963	-963	3	40	1.75	1.75
07/18/13	to	08/16/13	08/19/13	to	08/23/13		44,973		40,713				4	70	2.25	1.5
07/25/13	to	08/23/13	08/26/13	to	08/30/13	(213)	44,760	(233)	40,480	1	0	0	4	70	2.25	1.5
08/01/13	to	08/30/13	09/02/13	to	09/06/13		44,760		40,480				4	70	2.25	2.25
08/08/13	to	09/06/13	09/09/13	to	09/13/13		44,760		40,480				2	40	1.25	2
08/15/13	to	09/13/13	09/16/13	to	09/20/13	725	45,485	705	41,185	1	0	0	2	40	1.25	2
08/22/13	to	09/20/13	09/23/13	to	09/27/13		45,485		41,185				3	70	2.5	0.75
08/29/13	to	09/27/13	09/30/13	to	10/04/13	(175)	45,310	(195)	40,990	1	0	0	1	20	2.75	0.75
09/05/13	to	10/04/13	10/07/13	to	10/11/13		45,310		40,990				2	40	2.75	1
09/12/13	to	10/11/13	10/14/13	to	10/18/13	(638)	44,672	(658)	40,332	1	0	0	1	40	1.25	0.5
09/19/13	to	10/18/13	10/21/13	to	10/25/13	288	44,960	248	40,580	2	-200	-200	2	20	1.5	1.5
09/26/13	to	10/25/13	10/28/13	to	11/01/13	1,025	45,985	965	41,545	3	0	0	4	60	2.75	1
10/03/13	to	11/01/13	11/04/13	to	11/08/13	788	46,773	748	42,293	2	0	0	2	60	0.75	1.25
10/10/13	to	11/08/13	11/11/13	to	11/15/13	175	46,948	155	42,448	1	0	0	1	40	0.5	2
10/17/13	to	11/15/13	11/18/13	to	11/22/13	725	47,673	705	43,153	1	0	0	2	40	1.5	1.25
10/24/13	to	11/22/13	11/25/13	to	11/29/13		47,673		43,153				2	60	1.25	0.75
10/31/13	to	11/29/13	12/02/13	to	12/06/13	(175)	47,498	(215)	42,938	2	-638	-638	1	60	2.5	2.75
11/07/13	to	12/06/13	12/09/13	to	12/13/13		47,498		42,938				2	70	2.75	3
11/14/13	to	12/13/13	12/16/13	to	12/20/13		47,498		42,938				2	60	3	3
11/21/13	to	12/20/13	12/23/13	to	12/27/13		47,498		42,938				1	60	2.5	3
11/28/13	to	12/27/13	12/30/13	to	01/03/14	(175)	47,323	(195)	42,743	1	-175	-175	1	60	2.5	3
12/05/13	to	01/03/14	01/06/14	to	01/10/14	(63)	47,260	(103)	42,640	2	-238	-238	4	70	2.75	3
12/12/13	to	01/10/14	01/13/14	to	01/17/14		47,260		42,640				1	70	3	3
12/19/13	to	01/17/14	01/20/14	to	01/24/14		47,260		42,640				3	50	2.5	3
12/26/13	to	01/24/14	01/27/14	to	01/31/14	225	47,485	205	42,845	1	0	0	3	40	2.75	2.75
01/02/14	to	01/31/14	02/03/14	to	02/07/14	300	47,785	220	43,065	4	-163	-163	2	20	3	3
01/09/14	to	02/07/14	02/10/14	to	02/14/14		47,785		43,065				1	70	1.75	3
01/16/14	to	02/14/14	02/17/14	to	02/21/14		47,785		43,065				3	30	3	3
01/23/14	to	02/21/14	02/24/14	to	02/28/14	(275)	47,510	(295)	42,770	1	-275	-275	2	70	2.25	2.5
01/30/14	to	02/28/14	03/03/14	to	03/07/14	525	48,035	485	43,255	2	-138	-138	2	60	2.75	2.75
02/06/14	to	03/07/14	03/10/14	to	03/14/14	100	48,135	80	43,335	1	0	0	1	50	3	2.5

In-Sample Dates			Out-Of_Sample Dates			osnp	Eq	NOnp$20	NetEq	ont	ollt	odd	pw	N	vup	vdn
02/13/14	to	03/14/14	03/17/14	to	03/21/14	213	48,348	193	43,528	1	0	0	1	40	2.75	3
02/20/14	to	03/21/14	03/24/14	to	03/28/14	(250)	48,098	(290)	43,238	2	-175	-250	1	50	2.75	2.75
02/27/14	to	03/28/14	03/31/14	to	04/04/14	100	48,198	80	43,318	1	0	0	1	70	2.75	2.5
03/06/14	to	04/04/14	04/07/14	to	04/11/14		48,198		43,318				1	70	2.75	2.75
03/13/14	to	04/11/14	04/14/14	to	04/18/14		48,198		43,318				1	60	2.75	1.75
03/20/14	to	04/18/14	04/21/14	to	04/25/14		48,198		43,318				1	70	1.75	3
03/27/14	to	04/25/14	04/28/14	to	05/02/14	(250)	47,948	(310)	43,008	3	-563	-563	4	50	3	2.5
04/03/14	to	05/02/14	05/05/14	to	05/09/14	388	48,336	368	43,376	1	0	0	1	70	2.25	2.25
04/10/14	to	05/09/14	05/12/14	to	05/16/14		48,336		43,376				1	50	2.75	2
04/17/14	to	05/16/14	05/19/14	to	05/23/14		48,336		43,376				1	70	2.5	2.75
04/24/14	to	05/23/14	05/26/14	to	05/30/14		48,336		43,376				1	70	2.5	2.75
05/01/14	to	05/30/14	06/02/14	to	06/06/14	(1,063)	47,273	(1,103)	42,273	2	-1300	-1300	1	70	2.5	2.5
05/08/14	to	06/06/14	06/09/14	to	06/13/14		47,273		42,273				1	40	3	2.5
05/15/14	to	06/13/14	06/16/14	to	06/20/14		47,273		42,273				1	30	2.75	2.5
05/22/14	to	06/20/14	06/23/14	to	06/27/14	(150)	47,123	(170)	42,103	1	-150	-150	1	50	2.25	2.25
05/29/14	to	06/27/14	06/30/14	to	07/04/14	100	47,223	80	42,183	1	0	0	1	30	2.75	2.5
06/05/14	to	07/04/14	07/07/14	to	07/11/14		47,223		42,183				2	70	3	2.75
06/12/14	to	07/11/14	07/14/14	to	07/18/14	(488)	46,735	(528)	41,655	2	-400	-488	2	60	2.75	2
06/19/14	to	07/18/14	07/21/14	to	07/25/14		46,735		41,655				4	40	3	2.25
06/26/14	to	07/25/14	07/28/14	to	08/01/14	(138)	46,597	(178)	41,477	2	-263	-263	2	20	2.5	3
07/03/14	to	08/01/14	08/04/14	to	08/08/14		46,597		41,477				1	20	3	2.5
07/10/14	to	08/08/14	08/11/14	to	08/15/14	(388)	46,209	(408)	41,069	1	-388	-388	2	50	2.25	2.25
07/17/14	to	08/15/14	08/18/14	to	08/22/14		46,209		41,069				2	30	2.5	3
07/24/14	to	08/22/14	08/25/14	to	08/29/14		46,209		41,069				2	30	2.5	3
07/31/14	to	08/29/14	09/01/14	to	09/05/14	1,350	47,559	1,330	42,399	1	0	0	2	30	2.5	3
08/07/14	to	09/05/14	09/08/14	to	09/12/14	(150)	47,409	(170)	42,229	1	-150	-150	1	30	3	2.5
08/14/14	to	09/12/14	09/15/14	to	09/19/14	(250)	47,159	(290)	41,939	2	-175	-250	1	70	1.5	2.5
08/21/14	to	09/19/14	09/22/14	to	09/26/14	113	47,272	93	42,032	1	0	0	1	70	2	2.25
08/28/14	to	09/26/14	09/29/14	to	10/03/14	463	47,735	423	42,455	2	-25	-25	1	50	2.25	2.5
09/04/14	to	10/03/14	10/06/14	to	10/10/14	1,063	48,798	1,023	43,478	2	0	0	3	70	3	2.25
09/11/14	to	10/10/14	10/13/14	to	10/17/14	738	49,536	718	44,196	1	0	0	1	40	2.5	3
09/18/14	to	10/17/14	10/20/14	to	10/24/14	163	49,699	143	44,339	1	0	0	2	60	2.5	2.5
09/25/14	to	10/24/14	10/27/14	to	10/31/14	413	50,112	353	44,692	3	-125	-125	2	60	2.5	2.5
10/02/14	to	10/31/14	11/03/14	to	11/07/14	338	50,450	298	44,990	2	-63	-63	1	30	3	2.75
10/09/14	to	11/07/14	11/10/14	to	11/14/14	588	51,038	528	45,518	3	-513	-513	3	40	3	2.5
10/16/14	to	11/14/14	11/17/14	to	11/21/14	(313)	50,725	(353)	45,165	2	-275	-313	4	50	3	3
10/23/14	to	11/21/14	11/24/14	to	11/28/14	88	50,813	68	45,233	1	0	0	1	70	3	1.25
10/30/14	to	11/28/14	12/01/14	to	12/05/14	463	51,276	403	45,636	3	0	0	1	30	3	2.25
11/06/14	to	12/05/14	12/08/14	to	12/12/14		51,276		45,636				1	70	3	3
11/13/14	to	12/12/14	12/15/14	to	12/19/14	(1,513)	49,763	(1,593)	44,043	4	-950	-1675	1	30	2.5	3
11/20/14	to	12/19/14	12/22/14	to	12/26/14		49,763		44,043				2	70	2.25	3
11/27/14	to	12/26/14	12/29/14	to	01/02/15		49,763		44,043				2	70	2.25	3
12/04/14	to	01/02/15	01/05/15	to	01/09/15	175	49,938	155	44,198	1	0	0	2	70	2.25	3
12/11/14	to	01/09/15	01/12/15	to	01/16/15	(275)	49,663	(335)	43,863	3	-600	-600	1	50	3	2.25
12/18/14	to	01/16/15	01/19/15	to	01/23/15	1,963	51,626	1,903	45,766	3	-163	-163	2	70	2.75	3
12/25/14	to	01/23/15	01/26/15	to	01/30/15	(200)	51,426	(280)	45,486	4	-113	-238	1	70	3	2
01/01/15	to	01/30/15	02/02/15	to	02/06/15	1,563	52,989	1,503	46,989	3	-150	-150	1	70	2.75	2.25
01/08/15	to	02/06/15	02/09/15	to	02/13/15	(825)	52,164	(845)	46,144	1	-825	-825	1	70	2.75	2.25
01/15/15	to	02/13/15	02/16/15	to	02/20/15	563	52,727	523	46,667	2	-150	-150	1	40	2.75	2.5

In-Sample Dates			Out-Of_Sample Dates			osnp	Eq	NOnp$20	NetEq	ont	ollt	odd	pw	N	vup	vdn
01/22/15	to	02/20/15	02/23/15	to	02/27/15	1,338	54,065	1,298	47,965	2	-200	-200	1	60	2.75	2.25
01/29/15	to	02/27/15	03/02/15	to	03/06/15	500	54,565	440	48,405	3	0	0	3	70	3	2.25
02/05/15	to	03/06/15	03/09/15	to	03/13/15	(2,175)	52,390	(2,275)	46,130	5	-1088	-2875	1	40	2	3
02/12/15	to	03/13/15	03/16/15	to	03/20/15	1,613	54,003	1,513	47,643	5	-138	-138	2	50	2.5	3
02/19/15	to	03/20/15	03/23/15	to	03/27/15	1,350	55,353	1,270	48,913	4	0	0	1	60	2	2.25
02/26/15	to	03/27/15	03/30/15	to	04/03/15	(113)	55,240	(173)	48,740	3	-388	-388	1	50	2.75	2
03/05/15	to	04/03/15	04/06/15	to	04/10/15	563	55,803	523	49,263	2	-163	-163	1	40	3	2.5
03/12/15	to	04/10/15	04/13/15	to	04/17/15	588	56,391	468	49,731	6	-575	-1025	3	60	3	3
03/19/15	to	04/17/15	04/20/15	to	04/24/15	(388)	56,003	(428)	49,303	2	-325	-388	1	70	3	1.75
03/26/15	to	04/24/15	04/27/15	to	05/01/15	(1,438)	54,565	(1,498)	47,805	3	-1238	-1475	1	70	3	3
04/02/15	to	05/01/15	05/04/15	to	05/08/15	363	54,928	323	48,128	2	0	0	1	70	3	3
04/09/15	to	05/08/15	05/11/15	to	05/15/15	1,125	56,053	1,085	49,213	2	0	0	1	70	3	3
04/16/15	to	05/15/15	05/18/15	to	05/22/15	725	56,778	685	49,898	2	-350	-350	1	70	2	3
04/23/15	to	05/22/15	05/25/15	to	05/29/15	(200)	56,578	(240)	49,658	2	-200	-200	1	70	1.75	3
04/30/15	to	05/29/15	06/01/15	to	06/05/15	1,750	58,328	1,590	51,248	8	-538	-1200	3	70	2.25	3
05/07/15	to	06/05/15	06/08/15	to	06/12/15	788	59,116	728	51,976	3	-325	-363	1	70	2.25	2.75
05/14/15	to	06/12/15	06/15/15	to	06/19/15	200	59,316	180	52,156	1	0	0	2	50	3	3
05/21/15	to	06/19/15	06/22/15	to	06/26/15	125	59,441	65	52,221	3	-38	-38	3	70	3	2.5
05/28/15	to	06/26/15	06/29/15	to	07/03/15	(188)	59,253	(228)	51,993	2	-125	-188	1	70	3	3
06/04/15	to	07/03/15	07/06/15	to	07/10/15		59,253		51,993				1	70	2.5	2.5
06/11/15	to	07/10/15	07/13/15	to	07/17/15	(550)	58,703	(570)	51,423	1	-550	-550	2	60	2.75	3
06/18/15	to	07/17/15	07/20/15	to	07/24/15	(238)	58,465	(258)	51,165	1	-238	-238	4	40	2.75	3
06/25/15	to	07/24/15	07/27/15	to	07/31/15	1,938	60,403	1,878	53,043	3	0	0	4	40	3	3
07/02/15	to	07/31/15	08/03/15	to	08/07/15	(500)	59,903	(560)	52,483	3	-888	-888	1	70	3	2.5
07/09/15	to	08/07/15	08/10/15	to	08/14/15	(100)	59,803	(120)	52,363	1	-100	-100	4	60	3	3
07/16/15	to	08/14/15	08/17/15	to	08/21/15	(313)	59,490	(353)	52,010	2	-175	-313	3	70	3	2.5
07/23/15	to	08/21/15	08/24/15	to	08/28/15	(1,900)	57,590	(2,060)	49,950	8	-850	-2763	3	70	3	2.5
07/30/15	to	08/28/15	08/31/15	to	09/04/15	(363)	57,227	(423)	49,527	3	-575	-575	2	60	3	2.5
08/06/15	to	09/04/15	09/07/15	to	09/11/15	125	57,352	105	49,632	1	0	0	2	70	3	3
08/13/15	to	09/11/15	09/14/15	to	09/18/15	188	57,540	168	49,800	1	0	0	1	50	3	2.5
08/20/15	to	09/18/15	09/21/15	to	09/25/15	875	58,415	835	50,635	2	0	0	1	60	3	1.75
08/27/15	to	09/25/15	09/28/15	to	10/02/15	(713)	57,702	(753)	49,882	2	-550	-713	1	40	2.75	3
09/03/15	to	10/02/15	10/05/15	to	10/09/15		57,702		49,882				2	50	3	3
09/10/15	to	10/09/15	10/12/15	to	10/16/15	(88)	57,614	(108)	49,774	1	-88	-88	1	70	3	3
09/17/15	to	10/16/15	10/19/15	to	10/23/15	2,163	59,777	2,123	51,897	2	0	0	4	60	3	2.75
09/24/15	to	10/23/15	10/26/15	to	10/30/15	950	60,727	890	52,787	3	-413	-413	3	70	2.75	2.5
10/01/15	to	10/30/15	11/02/15	to	11/06/15	(363)	60,364	(383)	52,404	1	-363	-363	1	30	2.75	2.75
10/08/15	to	11/06/15	11/09/15	to	11/13/15	(325)	60,039	(365)	52,039	2	-263	-325	2	50	2.75	2.75
10/15/15	to	11/13/15	11/16/15	to	11/20/15	100	60,139	80	52,119	1	0	0	1	20	3	3
10/22/15	to	11/20/15	11/23/15	to	11/27/15		60,139		52,119				1	40	2.75	2.75
10/29/15	to	11/27/15	11/30/15	to	12/04/15	3,275	63,414	3,235	55,354	2	-300	-300	1	70	2.75	2.25
11/05/15	to	12/04/15	12/07/15	to	12/11/15	(650)	62,764	(690)	54,664	2	-350	-650	4	60	2.5	3
11/12/15	to	12/11/15	12/14/15	to	12/18/15	(450)	62,314	(530)	54,134	4	-813	-813	1	20	3	2.75
11/19/15	to	12/18/15	12/21/15	to	12/25/15		62,314		54,134				1	50	2.5	3
11/26/15	to	12/25/15	12/28/15	to	01/01/16	(288)	62,026	(308)	53,826	1	-288	-288	1	50	2.5	3
12/03/15	to	01/01/16	01/04/16	to	01/08/16	(550)	61,476	(590)	53,236	2	-975	-975	1	60	2.5	2.5

In-Sample Dates			Out-Of-Sample Dates			osnp	EQ	NOnp$20	NetEq	ont	ollt	odd	pw	len	vup	vdn
12/03/15	to	01/01/16	01/04/16	to	01/08/16	(550)	61476	(590)	53236	2	-975	-975	1	60	2.5	2.5
12/10/15	to	01/08/16	01/11/16	to	01/15/16		61476		53236				3	40	1.75	1.5
12/17/15	to	01/15/16	01/18/16	to	01/22/16	713	62189	673	53909	2	-131	-131	4	50	1.25	1.5
12/24/15	to	01/22/16	01/25/16	to	01/29/16		62189		53909				3	40	1.5	2
12/31/15	to	01/29/16	02/01/16	to	02/05/16	675	62864	655	54564	1	0	0	3	40	1.5	2
01/07/16	to	02/05/16	02/08/16	to	02/12/16		62864		54564				4	70	1.5	2.5
01/14/16	to	02/12/16	02/15/16	to	02/19/16		62864		54564				4	60	1.5	2.75
01/21/16	to	02/19/16	02/22/16	to	02/26/16		62864		54564				4	60	1.5	2.75
01/28/16	to	02/26/16	02/29/16	to	03/04/16	(513)	62351	(533)	54031	1	-513	-513	2	50	1.5	1.5
02/04/16	to	03/04/16	03/07/16	to	03/11/16	1988	64339	1948	55979	2	-1238	-1238	3	40	2.75	1.5
02/11/16	to	03/11/16	03/14/16	to	03/18/16	338	64677	318	56297	1	0	0	1	60	1	2.5
02/18/16	to	03/18/16	03/21/16	to	03/25/16		64677		56297				2	40	2.75	1.5
02/25/16	to	03/25/16	03/28/16	to	04/01/16		64677		56297				2	40	2.75	1.5
03/03/16	to	04/01/16	04/04/16	to	04/08/16		64677		56297				2	40	2.75	1.5
03/10/16	to	04/08/16	04/11/16	to	04/15/16		64677		56297				4	70	3	1
03/17/16	to	04/15/16	04/18/16	to	04/22/16	563	65240	543	56840	1	0	0	2	40	1.25	1
03/24/16	to	04/22/16	04/25/16	to	04/29/16	(531)	64709	(551)	56289	1	-531	-531	3	20	1.25	1.75
03/31/16	to	04/29/16	05/02/16	to	05/06/16	269	64978	249	56538	1	0	0	4	20	2.25	1.5
04/07/16	to	05/06/16	05/09/16	to	05/13/16	44	65022	24	56562	1	0	0	3	40	1.25	1
04/14/16	to	05/13/16	05/16/16	to	05/20/16		65022		56562				2	20	1.25	2
04/21/16	to	05/20/16	05/23/16	to	05/27/16	(250)	64772	(270)	56292	1	-250	-250	4	40	1	2

Appendix 1: *n*th Order Fading Memory Polynomial Next Bar's Forecast Math

What is The Nth Order Fading Memory Polynomial ?

This is a mathematical technique that fits a nth order polynomial to the last ***T*** price bars but calculates the coefficients of the polynomial such that the error between the current nth order polynomial and the current bar is weighted much higher than the error between the price T bars ago and the value of the nth order polynomial T bars ago. As an example, if the latest price is at time t and the price made a turn at time bar t-10 , then we do not want prices prior to t-10 affecting the current polynomial fit as much. As will be shown the most familiar case of this fading memory technique is the exponential moving average. The fading memory technique is in contrast to the Least Squares Polynomial fit, which weights all past errors between the polynomial and the price bar equally.

Consider a time series x(t) where t is an integer value (a price bar number) like the number of days or minutes, etc from some starting time. Suppose we want to find at some given time some *n*th-degree polynomial that fits the data well at current and recent prices but ignores the fit as we move into the distant past. One way to construct this type of fit would be to weight the past data with a number that got smaller and smaller the further back in time we went. If we let the polynomial function be represented by the symbol **p(t-τ)** where **p(t-0)** is the current value of the polynomial, **p(t-1)** is the previous value of the polynomial, etc., then an error function can be formed that consists of the weighted sum of the squared difference between the price series **x(t-τ)** and the polynomial p(t-τ) given by

$$\mathbf{error = \Sigma\beta^{\tau}(x(t\text{-}\tau) - p(t\text{-}\tau))^2 \quad \tau=0 \text{ to } \infty \qquad (1)}$$

where $\mathbf{0 < \beta < 1}$ **and** β^{τ} is much much less than **1** for large **τ.**

It turns out that if we let the nth degree polynomial **p(t-τ)** be constructed as a linear combination of orthogonal polynomials called Meixner polynomials then minimizing the error with respect to the coefficients of the orthogonal polynomials yields the best estimate of **x(t-τ)** as $\mathbf{x_{est}(t\text{-}\tau)}$ and given by the equation

$$x_{est}(t-\tau) = (1-\beta)\sum_{k=0}^{n}\beta^k b_{k,t}\Phi_k(t)|_{\tau} \qquad (2)$$

Where

$$\Phi_n(t) = \sum_{k=0}^{n}\binom{n}{k}\binom{t}{k}z^k$$

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

$$b_{j,t} = \sum_{k=0}^{\infty}\beta^k\Phi_j(k)x(t-k)$$

$$\mathbf{z = 1 - 1/\beta}$$

where n is the polynomial degree, $\mathbf{\Phi_k(\tau)}$ are the Meixner polynomials of degree k (k=0 to n), and $\mathbf{b_k(t)}$ are the coefficients that minimize the error of equation (1). Generally the summation for $\mathbf{b_j(t)}$ can be terminated when $\beta^{\mathbf{k}}$ <<1.

Appendix 1: *n*th Order Fading Memory Polynomial Next Bar's Forecast Math

For the exact mathematical solutions that produce equation (2) and the mathematical descriptions of the Meixner polynomials refer to Reference 1.

To yield the 1 day ahead prediction the above equation becomes;

$$\mathbf{x_{est}(t+1)=(1-\beta)\sum \beta^k b_{k,t}\Phi_k(-1)\ \ k=0\ to\ n} \qquad \mathbf{(3)}$$

After some algebraic manipulation with the Meixner polynomials the $\mathbf{b_{k,t}}$ coefficients satisfy the following recursive relationship.(see Reference 1)

$$\mathbf{b_{k,t}=\beta\ b_{k,t-1}+b_{k-1,t}-b_{k-1,t-1}}$$

One case is of immediate interest where the polynomial is a constant, that is ***n***=0.

For this case the solution to equation (3) can be found after some algebraic manipulation to be:

$$\mathbf{X0_{est}=\beta*X0_{est}[1]+(1-\beta)*x(t)} \qquad \mathbf{(4)}$$

Where $\mathbf{X0_{est}[1]}$ is the previous estimated value, **x(t)** is the current bar's price and where the 0 in $\mathbf{X0_{est}}$ indicates that we are estimating a polynomial of degree 0 or simply a constant. If a change of variables is made letting $\mathbf{\alpha=(1-\beta)}$ then equation (4) becomes:

$$\mathbf{X0_{est}=(1-\alpha)*X0_{est}[1]+\alpha*x(t)} \qquad \mathbf{(5)}$$

This is the familiar formula for the exponential moving average.

Higher orders of ***n*** don't yield such compact solutions as the case where ***n***=0 .equations

$$\mathbf{P_F(T+1) = (1-\beta)*[b_{0,t}\,\phi_{0|t=-1} + \beta b_{1,t}*\phi_{1|t=-1} + \beta^2 b_{2,t}*\phi_{2|t=-1} +\ldots+ \beta^n b_{n,t}*\phi_{n|t=-1}]}$$

$$\mathbf{Velocity = (dP_F/dt)_{(T=-1)} = (1-\beta)[\beta b_{1,t}*(d\phi_1/dt)_{|t=-1} + \beta^2 b_{2,t}*(d\phi_2/dt)_{|t=-1} +\ldots+ \beta^n b_{n,t}*(d\phi_n/dt)_{|t=-1)}]}$$

The nth Order Fading Memory Forecast Next Bar's Velocity System Defined

The least squares forecast is constructed by solving for the coefficients $\mathbf{b_0, b_1, b_2, \ , \ , b_n}$ recursively at each bar using the last **T** bars of closing prices and the Discrete Orthogonal Meixner Polynomial equations above. Then **Velocity** = $\mathbf{dP_F(T+1)/dt}$ is constructed from the velocity equation above and plotted under the price chart.   In general what we will be doing is following the plotted curve of **Velocity** which is calculated at each bar from the previous T bars.   When the velocity is greater than a threshold amount ***vup*** we will go long. When the velocity is less than a threshold amount ***-vdn*** we will go short.

Buy Rule:
IF Velocity is greater than the threshold amount ***vup*** then buy at the market.

Sell Rule:
IF Velocity is less than the threshold amount ***-vdn*** then sell at the market.

Appendix 1: n^{th} Order Fading Memory Polynomial Next Bar's Forecast Math

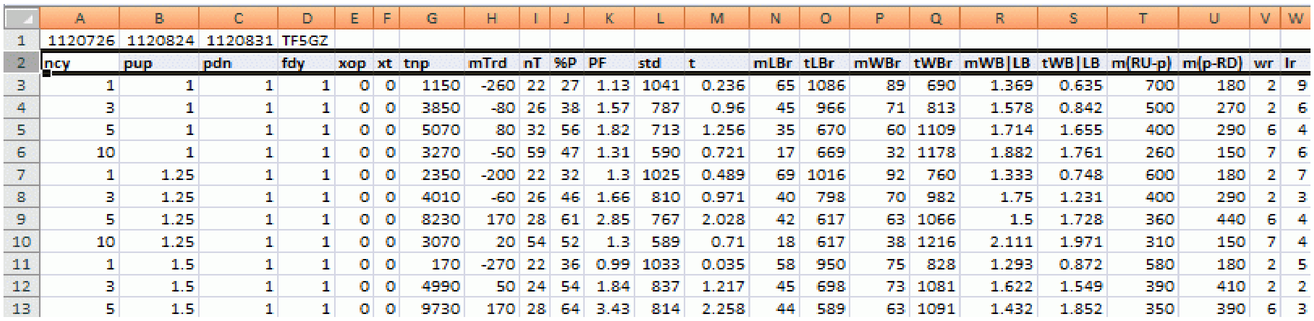
References

1. Morrison, Norman "Introduction to Sequential Smoothing and Prediction", McGraw-Hill Book Company, New York, 1969.

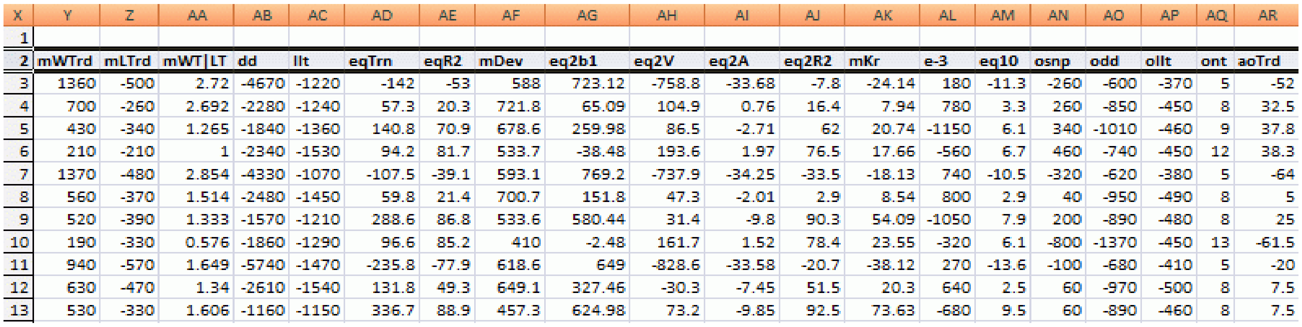
Appendix 2 Power Walk Forward Optimizer Performance Metrics

The PWFO Metric Performance Statistics Defined.

Shown below is the Excel spreadsheet of a PWFO file for the first 13 cases of an optimization run using the Goertzel Discrete Fourier strategy and The Power Walk Forward Optimizer. This example is not meant to show a profitable strategy but only the definitions of the PWFO columns. This strategy was run on the Russell 2000 futures five minute bars for a in-sample period of 30 calendar days from 7/26/2012 to 8/24/2012 and an out-of-sample period of 7 calendar days from 8/25/2012 to 8/31/2012. The first row of the spreadsheet shows the In-Sample(Test) dates and the out-of-sample dates and the “stub” PWFO input. In this case the In-Sample(Test) dates were from 1120726 to 1120824. The out-of-sample dates were from the next trading day after the Friday of 1120824 which was Monday 1120827 to Friday, 1120831. The 112MMDD designation is TradeStation’s compressed date format where 112 stands for the year 2012. 99 would stand for the year 1999 and 104 would stand for the year 2004. Below follows the definition of columns **A** through **AR** of the spreadsheet output.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	1120726	1120824	1120831	TF5GZ																			
2	ncy	pup	pdn	fdy	xop	xt	tnp	mTrd	nT	%P	PF	std	t	mLBr	tLBr	mWBr	tWBr	mWB|LB	tWB|LB	m(RU-p)	m(p-RD)	wr	lr
3	1	1	1	1	0	0	1150	-260	22	27	1.13	1041	0.236	65	1086	89	690	1.369	0.635	700	180	2	9
4	3	1	1	1	0	0	3850	-80	26	38	1.57	787	0.96	45	966	71	813	1.578	0.842	500	270	2	6
5	5	1	1	1	0	0	5070	80	32	56	1.82	713	1.256	35	670	60	1109	1.714	1.655	400	290	6	4
6	10	1	1	1	0	0	3270	-50	59	47	1.31	590	0.721	17	669	32	1178	1.882	1.761	260	150	7	6
7	1	1.25	1	1	0	0	2350	-200	22	32	1.3	1025	0.489	69	1016	92	760	1.333	0.748	600	180	2	7
8	3	1.25	1	1	0	0	4010	-60	26	46	1.66	810	0.971	40	798	70	982	1.75	1.231	400	290	2	3
9	5	1.25	1	1	0	0	8230	170	28	61	2.85	767	2.028	42	617	63	1066	1.5	1.728	360	440	6	4
10	10	1.25	1	1	0	0	3070	20	54	52	1.3	589	0.71	18	617	38	1216	2.111	1.971	310	150	7	4
11	1	1.5	1	1	0	0	170	-270	22	36	0.99	1033	0.035	58	950	75	828	1.293	0.872	580	180	2	5
12	3	1.5	1	1	0	0	4990	50	24	54	1.84	837	1.217	45	698	73	1081	1.622	1.549	390	410	2	2
13	5	1.5	1	1	0	0	9730	170	28	64	3.43	814	2.258	44	589	63	1091	1.432	1.852	350	390	6	3



X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR
1																				
2	mWTrd	mLTrd	mWT|LT	dd	llt	eqTrn	eqR2	mDev	eq2b1	eq2V	eq2A	eq2R2	mKr	e-3	eq10	osnp	odd	ollt	ont	aoTrd
3	1360	-500	2.72	-4670	-1220	-142	-53	588	723.12	-758.8	-33.68	-7.8	-24.14	180	-11.3	-260	-600	-370	5	-52
4	700	-260	2.692	-2280	-1240	57.3	20.3	721.8	65.09	104.9	0.76	16.4	7.94	780	3.3	260	-850	-450	8	32.5
5	430	-340	1.265	-1840	-1360	140.8	70.9	678.6	259.98	86.5	-2.71	62	20.74	-1150	6.1	340	-1010	-460	9	37.8
6	210	-210	1	-2340	-1530	94.2	81.7	533.7	-38.48	193.6	1.97	76.5	17.66	-560	6.7	460	-740	-450	12	38.3
7	1370	-480	2.854	-4330	-1070	-107.5	-39.1	593.1	769.2	-737.9	-34.25	-33.5	-18.13	740	-10.5	-320	-620	-380	5	-64
8	560	-370	1.514	-2480	-1450	59.8	21.4	700.7	151.8	47.3	-2.01	2.9	8.54	800	2.9	40	-950	-490	8	5
9	520	-390	1.333	-1570	-1210	288.6	86.8	533.6	580.44	31.4	-9.8	90.3	54.09	-1050	7.9	200	-890	-480	8	25
10	190	-330	0.576	-1860	-1290	96.6	85.2	410	-2.48	161.7	1.52	78.4	23.55	-320	6.1	-800	-1370	-450	13	-61.5
11	940	-570	1.649	-5740	-1470	-235.8	-77.9	618.6	649	-828.6	-33.58	-20.7	-38.12	270	-13.6	-100	-680	-410	5	-20
12	630	-470	1.34	-2610	-1540	131.8	49.3	649.1	327.46	-30.3	-7.45	51.5	20.3	640	2.5	60	-970	-500	8	7.5
13	530	-330	1.606	-1160	-1150	336.7	88.9	457.3	624.98	73.2	-9.85	92.5	73.63	-680	9.5	60	-890	-460	8	7.5

Columns A,B,C. These are the optimization run input parameters for each case.

The Columns below are the performance statistics for the In-Sample(Test) data on each case (row).

Column	Symbol	Column Definition For The In-Sample(Test) Section:
A - F		Input Parameters.
G	tnp	Total Net profits
H	mTrd	The median of all trades in the In-Sample section
I	nT	# of Trades in In-Sample(Test) Section
J	%P	% Profitable Trades in In-Sample(Test) Section
K	PF	Profit Factor
L	std	Standard Deviation of Trades
M	t	Student t Statistic. Used to determine the probability that the average trade Profit >0

Appendix 2 Power Walk Forward Optimizer Performance Metrics

Column	Symbol	Column Definition For The In-Sample(Test) Section:
N	mLBr	The Median of Bars in Losing Trades
O	tLBr	Total Losing Bars in Losing Trades
P	mWBr	The Median of Winning Trades Bars
Q	tWBr	Total Winning Bars in Winning Trades
R	mWb/mLb	Ratio of Median Winning Bars to Median Losing Bars
S	tWb/tLb	Ratio of Total Winning Bars to Total Losing Bars
T	m(ru-p)	Median of all Trades(Maximum Trade Run-up – Final Trade Profit)
U	m(p-rd)	Median of all Trades(Final Trade Profit - Maximum Trade Run-down)
V	wr	Max consecutive winners in a row
W	lr	Max consecutive losers in a row
Y	mWTr	Median of the winning trades
Z	mLTr	Median of the losing trades
AA	mWT/LT	Ratio of Median Winning Trades to Median Losing Trades
AB	dd	In-Sample(Test) Section Drawdown
AC	llt	Largest losing trade in In-Sample(Test) Section
AD	eqTrn	Slope of In-Sample Trade Equity Trend Line
AE	eqR2	Trade Equity Trend Line Coefficient Of Correlation r^2
AF	mDev	Median of the absolute deviations of equity from straight line fit to equity curve
AG	eq2b1	Slope Of Equity 2nd Order Polynomial Line Where Equity 2nd Order Line =$b_0 + b_1*t + b_2*t^2$
AH	eq2V	Velocity Of Equity 2nd Order Polynomial Line evaluated on last trade i=nT.
AI	eq2A	Acceleration of Equity 2nd Order Polynomial Line evaluated on last trade
AJ	eq2R2	Equity 2nd Order Polynomial Line Coefficient Of Correlation r^2
AK	mKr	Modified k-ratio = eqTrn/mDev.
AL	e-3	End Equity minus Equity 3 Trades before
AM	eq10	Projected Equity 10 Trades in Future Using 2nd Order Polynomial Line/1000.
	um	User Performance Metric
		Column Definition For Out-Of-Sample Section:
AN	osnp	Out-Of-Sample(OOS) Net Profit
AO	odd	OOS drawdown
AP	ollt	OOS largest losing trade
AQ	onT	OOS # of trades
AR	aoTr	Average OOS trade profit.

Appendix 2 Power Walk Forward Optimizer Performance Metrics

Explanation of The logic Behind The New Performance Statistics.

A number of performance statistics are new. This section will explain the logic behind the selection of these new statistics.

- **std - Trade Standard Deviation.**
  This is the standard deviation of the trade profits/losses in dollars.
- **t -** Student t-statistic. Used to determine the probability that the Average Trade Profit (tnp/nT)<>0 . Statistically, high values of t indicate that there is a very small probability that the sample average trade profit on the spreadsheet is <= zero and a random number. In real life, I find that if I screen out the top 5% of t values in Excel, I screen out a lot of curve fit input parameters. Same goes for mkr.
- **mLBr - Median Of The Trade Losing Bars.**
  Each losing trade takes a certain number of 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.
- **mWBr -Median Of The Trade Winning Bars**
  Each winning trade takes a certain number of bars. If we order the number of bars each winning trade takes then the median of all the winning trade bars is a robust statistic. We take the median of the winning trades bars to minimize the effect of large and small winning trade bars that may be outliers that that distort this statistic.
- **m(ru-p) – Median of All Trades(Maximum Trade Runup Minus Final Trade Profit)**
  This statistic measures the difference between the maximum profit (trade runup) of each trade and the final profit of the trade. mru is the median of this difference for all trades for the given input variables. The closer the final trade profit is to the maximum trade profit, the better the performance of the input variable. Thus we would want the median to be as small as possible. We use the median for this statistic, because we do not want the statistic distorted by a few outlier trades
- **m(p-rd) – Median of All Trades(Final Trade Profit Minus Maximum rundown of Trade).**
  This statistic measures the difference between the final profit of each trade and the maximum trade loss (rundown) of the trade. The farther the final trade profit is from the maximum trade drawdown, the better the performance of the input variable. Thus, we would want the median to be as large as possible. We use the median for this statistic, because we do not want the statistic distorted by a few outlier trades
- **mWTr- Median Of The Winning Trades.**
  This is the median of the winning trade profits. We take the median of the winning trades to minimize the effect of large winning trades that may be outliers that are not repeatable.
- **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.
- **mWT/LT – Median of Winning Trades divided by Median of Losing Trades|.**
  This is the ratio of mWTr to absolute value of mLTr. A high ratio indicates robustness indicating that the statistic of the median of the winning trades to losing trades is not caused by outliers.
- **eqTrn – Slope Of Trade Equity Regression Line.**
  The equity curve is fitted by a straight line where $\text{Equity}_{est} = a_0+b_0*t$. Equity_{est} is the straight line estimate of the Equity curve and **t** is the trade number. **b0** is the slope of the straight line which we designate as eqTrn The dimensions of **eqTrn** are dollars per trade.
- **eqR2 - Trade Equity Regression Trend Line Coefficient Of Correlation r2**
  r2 is a measure of how well a straight line fits the equity curve. R2 goes from 0 to 100. An R2 of 100 means the equity curve fits a straight line exactly. In general, a high value of r2 is desirable because it indicates trade profit consistency.
- **mDev - Median Of The Absolute Values Of (The Equity At Each Trade Minus The Equity Regression Trend Line)**
  Dev is the median of all the absolute values of the deviations of the equity curve from the Equity straight line regression. This measure is similar to the standard deviation. However, the standard deviation squares

each error(deviation of the equity curve from the Equity straight line regression) in it's sum it weights large deviations much more strongly and is highly distorted by outliers. I prefer to the robust median statistic.

- **mkr - Modified K-Ratio = 100*eqTrn/mDev.**
  Lars Kestner developed the K-ratio in *Technical Analysis of Stocks and Commodities*, March 1996. the K-ratio compares reward to risk. Lars K-ratio used the Standard deviation from the trend line. I felt this gave to high a weight to the large profits and large losses so I modified the K-ratio by using the mD**ev** described above.
- **eq2B1 - Slope Of Equity Curve Least Squares 2nd Order Polynomial Line $Equity_{est}$=b_0+ b_1*i +b_2*i^2**.
  The equity curve is fitted by a 2nd order polynomial where $Equity_{est}$ = b_0+b_1*i+b_2*i^2. $Equity_{est}$ is the estimate of the Equity curve and **i** is the trade number. **b_1** is the slope of the parabolic line. The dimensions of **b_1** are dollars per trade. Many times the Equity curve doesn't fit a straight line very well. This is especially true if the equity curve is increasing or decreasing faster near the last trades than it was near the first trades. In this case, b1 gives a better representation of the equity curve trend.
- **eq2V - Velocity Of Equity Curve Least Squares 2nd Order Polynomial Line.**
  This is a measure of how fast the equity curve is moving on the last trade. If eq2V is negative and eq2B1 is positive this indicates that the equity curve is trending down on the last trades. Since after the last In-Sample(Test) sample trade comes trades in real time, it's important to know what direction the equity curve was headed before you trade.
- **b2 - Acceleration Of Equity Curve Least Squares 2nd Order Polynomial Line**
  Where $Equity_{est}$= b_0+ b_1*i +b_2*i^2.
  The equity curve is fitted by a 2nd order polynomial where $Equity_{est}$ = b_0+ b_1*i+b_2*i^2. $Equity_{est}$ is the estimate of the Equity curve and **i** is the trade number. **b2** is the acceleration of the parabolic line. The dimensions of **b2** are dollars per $trade^2$. Many times the Equity curve doesn't fit a straight line very well. This is especially true if the equity curve is increasing or decreasing faster near the last trades than it was near the first trades. In this case, b2 is a measure of how fast the slope of the equity curve is changing. If b2 is positive the equity curve's slope is increasing upward meaning the equity is increasing faster than a straight line. If b2 is negative, the equity curve's slope is decreasing meaning the equity will start decreasing a some point in time if the equity continues to follow this parabolic curve.
- **eq2R2 - Equity Least Squares 2nd Order Polynomial Line Coefficient Of Correlation r^2**
  eq2R2 is a measure of how well a least squares 2nd order polynomial line fits the equity curve. Note: for a 2nd order polynomial eq2R2 can be negative. This is because the coefficient of correlation is for straight lines. 2nd Order and higher polynomials would be considered nonlinear. An r^2 of 100 means the equity curve fits a parabolic exactly. In general, a high value of r^2 is desirable because it indicates trade profit consistency.
- **e-3 – End Equity Minus Equity 3 Trades before.**
  This is another measure of the equity curve at the end. This shows what the equity trend is doing on the last three trades.
- **eq**10 - **Projected Equity 10 Trades in Future Using Curve Least Squares 2nd Order Polynomial Line/1000.**
  This is another measure of the equity curve 10 trades in the future. The projected equity is divided by 1000. This shows what the best estimate of the equity would be if it followed the least squares parabolic line for ten trades into the future. This performance variable can also serve as a curve fit alert. If eq10 is very high, this would indicate that the input parameters for this case have curve fit the noise and will not work well in the future. Using Excel you could exclude the Top 10% of eq10 cases.

Appendix 3 -The *Normalization Multiplier*

What is the Multiplier ?

The nth Order Fading Memory Polynomial, also called here an nth Order Polynomial, is the least square fit of a polynomial of the form $\mathbf{P_F(T+1) = (1-\beta)*[b_{0,t}\, \phi_{0|t=-1} + \beta b_{1,t} *\phi_{1|t=-1} + \beta^2 b_{2,t} *\phi_{2|t=-1} +\ldots+ \beta^n b_{n,t} *\phi_{n|t=-1}]}$ to a ***Fading*** number of past data points. Where **t** is discrete time bars. Time could be daily bars or one minute bars. We use the term "Fading Memory" because we weight the past data with a number that gets smaller and smaller the further back in time we go. It is assumed that the time bars occur at fixed intervals of time so tic bars would not be appropriate for this analysis. Suppose we want to find at some given time some *n*th-degree polynomial that fits the data well at current and recent prices but ignores the fit as we move into the distant past. One way to construct this type of fit would be to weight the past data with a number that got smaller and smaller the further back in time we went. This type of error minimization is mathematically solvable and is widely used in science and mathematics. Once the $\mathbf{b_n}$ coefficients are found then the next bar's estimate **(T+1)** of the nth order polynomial Acceleration and acceleration can be easily found by the equations below.

$$\textbf{Velocity} = (dP_F/dt)_{(T=-1)} = (1-\beta)[\beta b_{1,t} *(d\phi_1/dt)_{|t=-1} + \beta^2 b_{2,t} *(d\phi_2/dt)_{|t=-1} +\ldots+ \beta^n b_{n,t} *(d\phi_n/dt)_{|t=-1)}]$$

$$0<\beta<1$$

Please see the ***n*th Order Fading Memory Polynomial Next Bar's Forecast Math** section for a more detailed explanation.

For any tradable, the inputs to the polynomial are the **polynomial degree(aka Order)** and exponential decay constant β. When we plot the velocity we notice that the amplitude, and the maximum and minimum values of and standard deviation of the velocity vary quite significantly with different polynomial degree and β inputs.

Below is a table of the standard deviation of the 304156 calculated Velocity values for different **degree** and β inputs. The lookback period **N (number of bars of past data)** is approximately related to α **(**α**=1-**β**)** by the formula α**=2/(1+N)**. I use **N** because it gives a better understanding of how many bars of past data are approximately being used. We used 1 min bars of the E-Mini from 5/1/2012 to 5/1/2015 to generate this table.

ES 1 min bars Date Range 1120501 to 1150501
Total Number of Bars=304156 Norm=0
Trading Times Constraint Start Time=0 EndTime=0
FadmVn Multiplier to Scale Velocity pw and N Range to One Std

degree	N	Std	1/Std
1	20	0.095791	10.4394
1	30	0.078206	12.7867
1	40	0.0678338	14.7419
1	50	0.0607871	16.4509
1	60	0.0555952	17.9872
1	70	0.051562	19.3941
2	20	0.166382	6.01027
2	30	0.135156	7.39888
2	40	0.116914	8.55332
2	50	0.104594	9.56079
2	60	0.0955577	10.4649
2	70	0.0885688	11.2907
3	20	0.229464	4.35799
3	30	0.185563	5.38902
3	40	0.160108	6.2458
3	50	0.143001	6.99297
3	60	0.13048	7.66398
3	70	0.120815	8.27714

4	20	0.288656	3.46433
4	30	0.232499	4.30109
4	40	0.200125	4.99688
4	50	0.178495	5.60241
4	60	0.162712	6.14583
4	70	0.150529	6.64324

The standard deviation varies from 0.06 to 0.28. The problem may get worse when we want to find good inputs for other tradables. Other tradables, because of their scales and tick size have much different Velocity ranges then the E-Mini for the same degree and N. Thus the search ranges have to be different for each different tradable, N and degree.

To solve this problem and to have a standard search space for each tradable, I created a **Mult** input for each FadmV Velocity strategy and indicator .. If each tradable's Velocity is multiplied by a number such that the standard deviation of that tradable's Velocity is close to one standard deviation then the search space for vup and vdn for each tradable would be 0 to 3 standard deviations and we wouldn't have to change the optimization search space every time we wanted to examine a new stock or future. The complicated equations that I use to normalize the ranges to one standard deviation for degree and N were derived using the software TableCurve 3D, automated surface and equation discovery. These equations are independent of the tradable and only depend on the polynomial degree and N. If you do not wish to use these equations then set iNorm=0. See note below .

How to Find The Mult.

Here is how to use the #**FadmVMultStd**. First load your chart with as much data as you are going to use. *Click* on **Insert-> Indicator**. Select the #**FadmVMultStd.** Modify the inputs to the indicator or just leave them at their default values. A table will be produced as shown below.

```
ES 1 min bars Date Range 1120501 to 1150501
Total Number of Bars=304156 Norm=1
Trading Times Constraint Start Time=0 EndTime=0
FadmVn Multiplier to Scale Velocity pw and N Range to One Std
```

pw	N	Std	1/Std	Std*Mult
1	20	0.351595	2.84418	0.988397
1	30	0.356036	2.80871	1.00088
1	40	0.360451	2.7743	1.01329
1	50	0.364442	2.74392	1.02451
1	60	0.368006	2.71735	1.03453
1	70	0.371198	2.69398	1.04351
		pw=1 Ave	2.76374	
2	20	0.34978	2.85894	0.983297
2	30	0.352419	2.83753	0.990715
2	40	0.355826	2.81036	1.00029
2	50	0.359166	2.78423	1.00968
2	60	0.362289	2.76023	1.01846
2	70	0.365198	2.73824	1.02664
		pw=2 Ave	2.79825	
3	20	0.348198	2.87193	0.978848
3	30	0.349252	2.86327	0.98181
3	40	0.351728	2.84311	0.98877
3	50	0.354446	2.82131	0.996412
3	60	0.357074	2.80054	1.0038
3	70	0.359576	2.78105	1.01083
		pw=3 Ave	2.8302	
4	20	0.34757	2.87712	0.977083

4	30	0.347231	2.87993	0.97613
4	40	0.348855	2.86652	0.980694
4	50	0.351063	2.84849	0.986903
4	60	0.353331	2.83021	0.993277
4	70	0.3555	2.81294	0.999376
		pw=4 Ave	2.85253	
		Mult=	2.81118	

For each tradable chart:

1. Apply the **FadmVMultStd** indicator to your chart.
2. Find the Multiplier as shown above.
3. Record the multiplier value and delete the indicator from your chart.
4. **Apply that multiplier to the Mult input** with **iNorm=1** in the strategy.
5. Do the parameter search for vup & vdn in the default range 0.25 to 3 by 0.25 .

Added Note:

The complicated equations that I use to normalize the ranges to one standard deviation were derived using the software TableCurve 3D, automated surface and equation discovery. These equations are independent of the tradable and only depend on the polynomial degree and N. If you do not wish to use these equations then set inorm=0. Then when you run **FadmVMultStd with inorm =0** you will get a multiplier that gives an average of all the ranges. With iNorm=0 you will have to determine the vup -vdn ranges for your optimization. They will be different for different tradables and time bars. Below is the output for iNorm=0 for **FadmVMultStd.** As you can see the variation for degree(pw)=2 is 6 times the variation for degree=4. And the variation for n-70 is five times the variation for N=20. so for this example in order to cover all degree and N ranges at 3 standard deviations maximum you would have to go from vup/vdn from 0.0005 to 0.09. Of course the best solution for iNorm=0 would be to modify the strategy multiplier for each degree and N which is essentially what my equation does but not as exact.

```
ES 1 min bars Date Range 1120501 to 1150501
Total Number of Bars=304156 Norm=0
Trading Times Constraint Start Time=0 EndTime=0
FadmVn Multiplier to Scale Velocity pw and N Range to One Std
```

pw	N	Std	1/Std	Std*Mult
2	20	0.00480974	207.912	1.82314
2	30	0.00259815	384.889	0.984833
2	40	0.00168332	594.062	0.638066
2	50	0.00120375	830.734	0.456284
2	60	0.000915983	1091.72	0.347204
2	70	0.000727482	1374.6	0.275753
		pw=2 Ave	747.321	
3	20	0.0139613	71.6267	5.29203
3	30	0.0075431	132.572	2.85922
3	40	0.00488588	204.671	1.852
3	50	0.00349297	286.289	1.32401
3	60	0.00265688	376.381	1.00709
3	70	0.00210918	474.118	0.799487
		pw=3 Ave	257.61	
4	20	0.0271776	36.795	10.3017
4	30	0.0146963	68.0445	5.57064
4	40	0.00951941	105.049	3.60834
4	50	0.00680606	146.928	2.57984
4	60	0.00517708	193.159	1.96238
4	70	0.0041091	243.362	1.55756
		pw=4 Ave	132.223	
		Mult=	379.051	