Trading 1Min Bar Euro Futures Using
The Fading Memory Polynomial Velocity Strategy
Jan/2008 –Jan/2016

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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 2nd 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 419 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 nth 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 419 weeks of EC (see Walk forward Testing below) creating 419 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 419 weeks of EC one minute bar price data into 419 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 419 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 419 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 419 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

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 419 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 sample **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 419 in-sample sections and applies these inputs to each of the 419 out-of-sample sections. Using the filter in-sample strategy inputs on the 419 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 10** 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 10** 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 419 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 419 PWFO files. At the end, each of the 5000 mirror filters will have 419 ***random*** OSNP's picked from the rows of the 419 PWFO files. The sum of the 419 random OSNP picks for each mirror filter 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 ***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 10 in Figure 3 the expected number of cases that we could obtain by pure chance that would match or exceed the tOnpNet of $53,236 of Row 10 is 28830 x 7.71 10^{-7} = 0.022. 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 419 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 419 weeks ending 1/4/08 to 1/8/16. 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 419 PWFO files of the EC 1min bars Nth Order Fading Memory Velocity System

Discussion of System Performance

In Figure 3 Row 10 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 47.5 weeks for this filter. This means we would have to trade this strategy for at least 47.5 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 2^{nd}, 3^{rd} and 4^{th} order velocity with ***degree= 2, 3 and 4***. The 3^{rd} and 4^{th} 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 1^{st} or 2^{nd} order curve velocity. When the noise level is lower in the in-sample section, it switches to the faster changing 3^{rd} or 4^{th} order curve velocity.

Using this filter, the strategy was able to generate $53,236 net equity after commissions and slippage trading one EC contract for 419 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 419 out-of-sample weeks the filter only traded 230 of those weeks or 55% of the time with 60% of all trades 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.

Disclaimer

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

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 – 01/08/16

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.

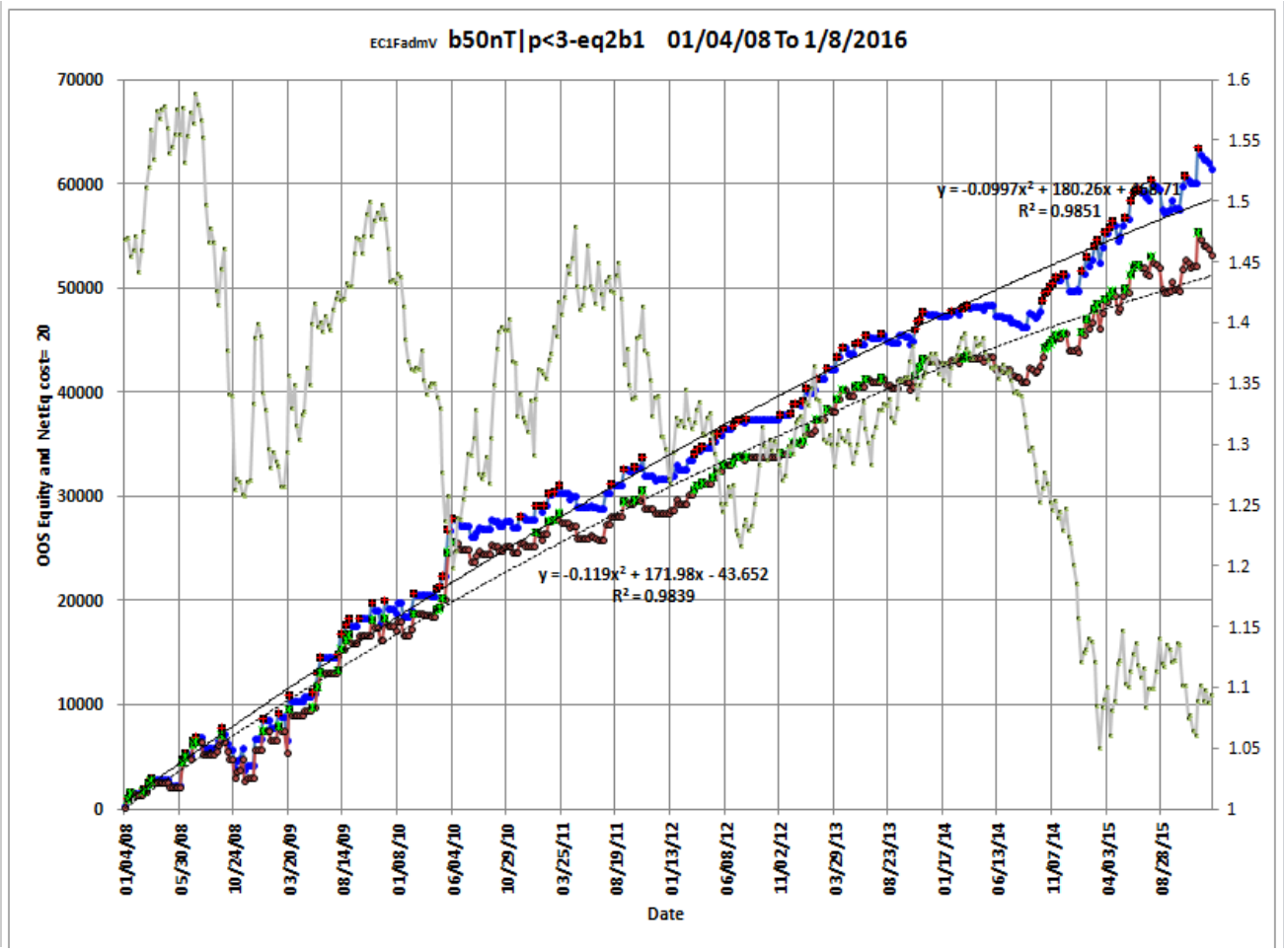

Figure 2 Walk Forward Out-Of-Sample Performance for EC Fading Memory Polynomial Velocity System
1 minute bar chart of EC from 12/3/16-12/4/16

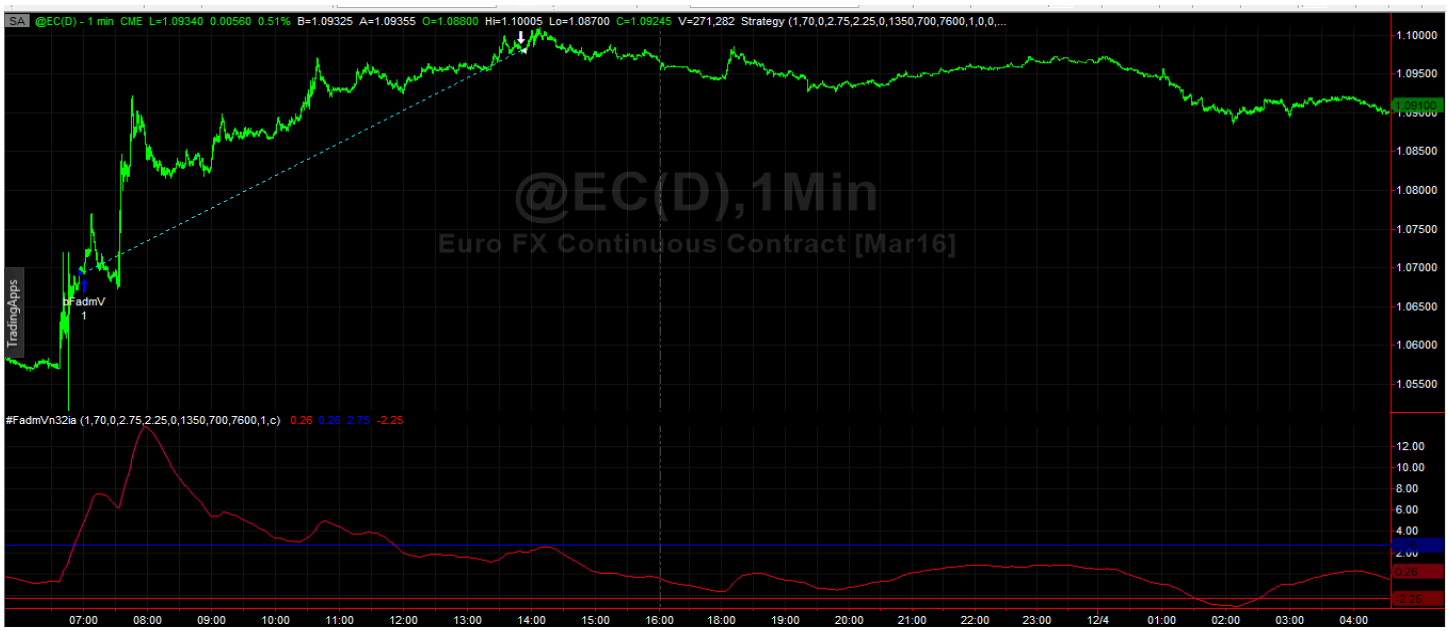

Figure 3_ Partial output of the Walk Forward Metric Performance Explorer (WFME)
EC1 min bars Nth Order Fading Memory Velocity System

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	EC1FadmV	s01/04/08	e01/08/16	#419	AnyTnp				a(72902)	s26247	f28830									c=$ 20	
2	Filter-Metric	tOnp	aOnp	aOTrd	aO#T	B0	%P	t	std	LLp	eqDD	lr	#	eqTrn	eqV^2	eqR2	Dev^2	Blw	BE	tOnpNet	Prob
3	t10mWT|LT|p<2|lr3-mWb	89252	251	77.0	3.3	(0.6)	59	4.52	1047	-3838	-8504	6	356	189	96	95	5262	59	69.8	66072	5.96E-08
4	t10eq2b1|p<1.5-dd	72124	247	84.6	2.9	(2.2)	57	4.11	1027	-2725	-5889	7	292	143	-24	88	6348	90	69.2	55064	5.43E-07
5	t10mLTr|p<2.5|lr3-llt	78404	265	66.4	4	(0.8)	61	4.26	1070	-3125	-5951	4	296	164	176	97	3413	59	65.3	54784	5.73E-07
6	b50nT|p<1.5|lr3-mWb	66112	249	116.2	2.1	(0.9)	59	4.62	880	-4263	-4800	6	265	140	78	97	3214	30	49.7	54732	5.79E-07
7	b50nT|p<2.5|lr3-eq2b1	62749	269	143.3	1.9	(1.2)	58	4.32	952	-2250	-3412	5	233	132	60	95	3621	30	50	53989	6.67E-07
8	b10nT|lr3-mWb	61372	266	154.2	1.7	(0.6)	63	4.8	842	-2013	-4090	8	231	120	74	96	3079	77	40.2	53412	7.45E-07
9	t50eq2V|p<2|lr3-mWT|LT	74793	224	69.9	3.2	(0.9)	59	3.77	1087	-3675	-6200	5	334	146	15	91	5632	64	94.2	53393	7.48E-07
10	b50nT|p<3-eq2b1	61476	267	149.2	1.8	(1.0)	60	4.4	921	-2175	-4013	5	230	138	97	98	2440	28	47.5	53236	7.71E-07
11	b10nT-mWb	61023	265	155.3	1.7	(0.6)	63	4.79	840	-2013	-3651	7	230	119	73	96	3059	77	40.1	53163	7.81E-07
12	b10nT|lr5-mWb	61023	265	155.3	1.7	(0.6)	63	4.79	840	-2013	-3651	7	230	119	73	96	3059	77	40.1	53163	7.81E-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(01/08/16), **Number of weeks**(#419) **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 419 week statistics on row 10.

tOnp = Total out-of-sample(oos) net profit for these 419 weeks.

aOsp = Average oos net profit for the 419 weeks

aOTrd = Average oos profit per trade

aO#T = Average number of oos trades per week

B0 = The 419 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 419 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 419 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 - 01/08/2016. 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<2.5|lr3-eq2b1 PF<=2.5, LR<=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 2nd 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

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

What is The N^{th} Order Fading Memory Polynomial ?

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.

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

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

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

It turns out that if we let the n^{th} 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 $\mathbf{x_{est}(t-\tau)}$ 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 $\mathbf{\beta^k}$ <<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;

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

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

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

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:

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

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

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

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

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

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

$$\text{Accel} = (d^2P_F/d^2t)_{(T=-1)} = (1-\beta)[\beta^2 b_{2,t}*(d^2\phi_2/d^2t)_{|t=-1} + \beta^2 b_{2,t}*(d^2\phi_3/d^2t)_{|t=-1} +\ldots+ \beta^n b_{n,t}*(d^2\phi_n/d^2t)_{|t=-1}]$$

The n^{th} Order Fading Memory Forecast Next Bar's Price System Defined

The least squares forecast is constructed by solving for the coefficients $b_0, b_1, b_2, \ , \ , b_n$ recursively at each bar using the last **T** bars of closing prices and the Discrete Orthogonal Meixner Polynomial equations above. Then $P_F(T+1)$ is constructed from the equation above and plotted under the price chart. In general what we will be doing is following the plotted curve of P_F which is calculated at each bar from the previous T bars. When the curve increases by a percentage amount ***pctup*** from the previous prior low of the curve we will go long. When the curve falls by the percentage amount ***pctdn*** from the previous prior high of the curve we will go short

Buy Rule:

- **IF** P_f has moved up by more than the percentage amount of ***pctup*** from the lowest low recorded in P_f while short then buy at the market.

Sell Rule:

- **IF P_f** has moved down by more than the percentage amount ***pctdn*** from the highest high recorded in **P_f** while long then sell at the market.

The n^{th} Order Fading Memory Forecast Next Bar's Velocity System Defined

The least squares forecast is constructed by solving for the coefficients $b_0, b_1, b_2, \ , \ , b_n$ recursively at each bar using the last **T** bars of closing prices and the Discrete Orthogonal Meixner Polynomial equations above. Then **Velocity** = $dP_F(T+1)/dt$ 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.

The n^{th} Order Fading Memory Forecast Next Bar's Acceleration System Defined

The least squares forecast is constructed by solving for the coefficients $b_0, b_1, b_2, \ , \ , b_n$ recursively at each bar using the last **T** bars of closing prices and the Discrete Orthogonal Meixner Polynomial equations above.. Then **Acceleration** = $d^2P_F(T+1)/d^2t$ is constructed from the acceleration equation above and plotted under the price chart. In general what we will be doing is following the plotted curve of **Acceleration** which is calculated at each bar from the previous T bars. When the acceleration is greater than a threshold amount ***aup*** we will go long. When the velocity is less than a threshold amount ***-adn*** we will go short.

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

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

References

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

