Trading SPY 30min Bars with the 5 parameter Parabolic

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The Parabolic Stop and Reversal Indicator

The Parabolic stop and reversal indicator was introduced by J. Welles Wilder in *New Concepts in Technical Trading Systems.* The Parabolic is a trend following indicator which is always long or short the market. This indicator is now standard on all modern technical analysis software. The Parabolic can be applied to any bar chart such as, monthly, weekly, daily, hourly, or even point and figure charts.

The Parabolic creates a trailing stop that is at first far enough away from the initial buy price so that price retracements in the early stages of the trend do not drop below the trailing stop price and stop you out of your position. As the price trend matures the trailing stop moves closer and closer at an accelerating rate to recent local lows of the current price, until the stop is penetrated by an adverse price movement and a sell signal is given (opposite logic applies for sell signal).

The shape, slope and speed of the Parabolic is controlled by three parameters, the starting acceleration factor (startAF), the increment that the starting acceleration factor can change when a new price high or low is made (incAF), and the maximum acceleration factor (maxAF), the maximum value the acceleration factor can be increased to. Because of the way the Parabolic is calculated, the shape of the trend following curve resembles a parabolic type curve, hence it's name.

We will demonstrate the calculation of the Parabolic with the 30 min bar chart of SPY in Figure 1 and the Excel spreadsheet of SPY data and Parabolic curve calculations in Figure 2.

The Parabolic parameters are startAF=0.02, incAF=0.02 and maxAF=0.20. On 04/03/14 at 1500, SPY broke through to the upside of the previous day's down sloping Parabolic stop loss of 188.75. A buy position was established at the stop loss price of 188.05. The stop loss was put at the lowest low of the previous downtrend which was 188.05. Thus the first stop loss value of the Parabolic on 04/03/13 at 1500 is 188.05 and the AF is equal to the starting AF of 0.02. The next bar, 04/04/14 at 900, SPY made a new high of 189.70. Since SPY made a new high the starting AF is increased by incAF to 0.04 for the next calculation of the new stop loss. The new stop loss is calculated as New Stop Loss = 188.05 + 0.02*(189.70 -188.05) = 188.08. The general formula is:

New Stop Loss = Old Stop Loss + AF*(EP – Old Stop Loss)

Where EP(extreme price) is equal to the highest high encountered while long or the lowest low encountered while short. In addition AF is only increased if a new high is made. Otherwise AF stays the same. AF can only be increased to the maximum AF.

On 04/04/14 @11:00 the low of SPY broke through the stop loss of 188.22 to the downside. The market position of SPY went from long to short with a stop at the previous high while long of 189.70. At 4/4/14 @ 11:30 SPY mad a new low so AF was increased by 0.02 to 0.04 and a new stop loss of 189.7+0.02(187.06-189.7)=189.65. On 4/4/14 @ 12:00 SPY made a new low of 187.17. AF is increased by 0.02 to 0.06 and the new stop loss is 189.65 +0.04(187.17-

189.65)=189.55. This procedure is followed until 04/07/14 @14:00 where the high of SPY broke the stop loss to the upside and a long position was establish.

Most software packages only allow one to vary the AF increment and the AF maximum, fixing the starting AF at 0.02. This restriction hampers the trend following abilities of the Parabolic and will be relaxed in this study by allowing different starting values in our search for optimum parameters later in this article..

The 5 Parameter Parabolic

Many times as the Parabolic stop loss hugs the price curve it is penetrated by a price bar by a small amount, as it was on 4/08/14 in Figure 1, generating an opposite signal. The price then immediately turns around and resumes going in the direction it was going before this penetration occurred causing a costly whipsaw loss. Many of the whipsaws losses are caused by noise or spurious movements in the price. Thus if the Parabolic stop loss is to represent the trend of a real price series it must have the capability to ignore small penetrations of noise level amounts. To this end, I have modified the Parabolic Stop Loss formula to include a variable that allows the Parabolic stop loss not to reverse unless penetrated by a defined amount. I define this new parameter as **xo**, for noise crossover increment. In addition the initial starting value for the stop loss is always set at the previous low or high EP. In some instances the system will produces less whipsaws if the initial starting value of the stop loss is the previous high plus some amount called **xpr** or the previous low minus **xpr**. I call this new five parameter Parabolic, **parabxot**.

Data Discussion

To test this system we will use 30 minute bar prices of the SPDR S&P 500 ETF traded on the NYSE and known by the symbol SPY for the 106 weeks from March 1 2012 to April 11 2014.

We will test this strategy with the above SPX 30 min bars on a walk forward basis, as will be described below. In TradeStation (TS), we will run the Parabxot Strategy on the SPY 30 min data from March 1 2012 to April 11 2014. We will breakup and create 30 day calendar in-sample sections along with their corresponding one calendar week out-of-sample sections from the 106 weeks of SPY (see Walk forward Testing below) creating 106 out-of-sample weeks.

In-Sample Section and Out-Of-Sample Section Definition

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(IS)*** 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 were due to chance, over fitting the IS section or 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.

The Parabxot System Defined

In general what we will be doing is following the plotted curve of **parabxot** . When the price of the current bar exceeds the previous bar value of the parabxot by the amount **xo,** we will go long. When the price of the current bar fall below the previous bar value of the parabxot by the amount **xo,** we will go short.

Buy Rule:

- **Buy parabxot[1] + xo Stop**.

Sell Rule:

- **Sell parabxot[1] –xo Stop**.

Where parabxot[1] is the previous bar value of parabxot.

Finding The System Parameters Using Walk Forward Optimization

There are five system parameters to find. ***Start***, the starting value of AF. ***Inc***, the amount AF is incremented, ***max***, the maximum amount AF can go to. ***xo***, the noise amount the price bar has to cross over the parabolic curve in order to generate a buy or sell signal and ***xpr***, the extra amount to add or subtract from the staring price of the parabolic stop loss.

For our computer run we will break up the 106 weeks of SPY 30 minute bar price data into 106 in-sample/out-of sample files. The in-sample(IS) 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 calendar day in-sample section. As an example the first in-sample section would be from 3/1/2012 to 3/30/2012 and the out-of-sample section would be the week following from 4/2/2012 to 4/6/2012. We would then move everything ahead a week and the 2nd in-sample section would be from 3/8/2012 to 4/6/2012 and the week following out-of-sample section would be from 4/9/2012 to 4/13/2012. Etc.

The 106 in-sample/out-of-sample section dates are shown in **Table 1** on page 11 below.

For the in-sample data we will run the TradeStation optimization engine on the 106 weeks of SPY 30 min bars with the following ranges for the Five Parameter Parabolic strategy input variables.

1. **start** from 0.01 to 0.02 in steps of 0.01
2. **inc** from 0.01 to 0.05 in steps of 0.01.
3. **max** from 0.06 to 0.3 in steps of 0.02
4. **xo** from 0 to 0.6 in steps of 0.1
5. **xpr** from 0 to 0.6 in steps of 0.1

This will produce 6370 different cases or combinations of the strategy input parameters for each of the 106 in-sample/out-of-sample files for the two years of SPY 30min bar data.

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 IS 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 IS 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 on average. ***Mathematical note:*** This assumption assumes that the out-of-sample returns are from probability distributions that have a finite variance.

Why use the walk forward technique? Why not just perform an optimization on the whole price series and choose the input parameters that give the best total net profits or profit factor or some other chosen metric? Surely the price noise cancels itself out with such a large number of in-sample prices and trades. Unfortunately, nothing could be farther from the truth! Optimization is a misnomer and should really be called combinatorial search. As stated above, whenever we run a combinatorial search over many different combinations of input parameters on noisy data on a fixed number of prices, ***no matter how many***, the best performance parameters found are guaranteed to be due to ***"curve fitting"*** the noise and signal. 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 strategy input variables that are able to produce profits from the price pattern ***and*** the random spurious movements. While the price patterns will repeat, the same spurious price movements will not. If the spurious movements that were captured by a certain set of input parameters were a large part of the total net profits, as they usually are in real price data, then choosing these input parameters will produce losses when traded on future data. These losses occur because the random price movements will not be repeated in the same way. This is why strategy optimization, neural net optimizations or combinatorial searches with no out-of-sample testing cause loses when traded in real time from something that looked great in the in-sample section. It is human nature to look for patterns and extrapolate past performance to project future trading results. However, results from curve fitting give the illusion, a modern "siren call" so to speak, of future trading profits, that will not exist.

In order to gain confidence that our input parameter selection method using the optimization output of the in-sample data will produce profits on data it hasn't been tested on, 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 twice or 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 or luck 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 IS/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 range for N weeks in the future.

Finding The Strategy Input Parameters in The Walk Forward Test Sections

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

When TS does an optimization over many combinations of inputs, it creates an output page that has as its rows each strategy input combination and as it's columns various trading performance measures or metric such as Profit Factor, Total Net Profits, etc. An example of a simple filter would be to choose the strategy input row in the in-sample section that had the highest Net Profit or perhaps a row that had the best Profit Factor with their associated strategy inputs. Unfortunately it was found that this type of simple metric performance filter very rarely produces good out-of-sample results. More complicated metric filters can produce good out-of-sample results minimizing spurious price movement biases in the selection of strategy inputs.

Here is an *example* of a better and more complicated ***filter*** that was used in this paper. There is a performance metric called **mLTr. mLTr** is the median of the losing trade losses for a given set of strategy inputs. We take the median of all the losing trades to minimize the effect of large losing trades that may be outliers that are not repeatable and that would distort an average. We take median of the **mLTr metric** for all the trades for the given set of input variables. Thus we would want the median to be as small as possible. The smaller **mLTr** is, the more efficient the strategy is in minimizing loses from each trade. Let us choose the 20 rows in the IS section that contain the **smallest(bottom) 20 mLTr** values. In other words we sort **mLTr** from low to high.. This particular filter will now leave 20 cases or rows in the in-sample section that satisfy these filter conditions. We call this part of the filter **b20(mLTr)**. Suppose for this filter, within the 20 in-sample section rows that are left, we want the row that has the metric called the equity curve straight line correlation coefficient in the in-sample section. This metric fits a straight line to the equity curve generated by the profit and losses of a set of strategy inputs and computes the correlation coefficient. A measure of how well a straight line fits the equity curve and called r^2 Thus, we would want r^2 of the equity curve to be as large as possible. We call equity curve straight line correlation coefficient metric **eqR2.** This would produce a final filter named **b20(mLTr)-eqR2**. For each in-sample section this filter leaves only one row in the in-sample section with its associated strategy inputs and out-of-sample net profit in the out-of-sample section using the strategy inputs found in the in-sample section. This particular **b20 (mLTr)-eqR2 filter** is then applied to each of the 106 in-sample sections which give 106 sets of strategy inputs that are used to produce the corresponding 106 weeks of out-of-sample performance results. The average out-of-sample performance is calculated from these 106 weeks of out-of-sample performance results. In addition many other important out-of-sample performance

statistics for this filter are calculated and summarized. **Figure 3** shows such a computer run along with a small sample of other filter combinations that are constructed in a similar manner. Row 3 of the sample output in **Figure 3** shows the results of the filter discussed above.

Bootstrap Probability of Filter Results: Using modern "Bootstrap" techniques, we can calculate the probability of obtaining 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 106 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 106 PWFO files. At the end, each of the 5000 mirror filters will have 106 ***random*** OSNP's picked from the rows of the 106 PWFO files. The sum of the 106 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 961(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 (961) X (tOnpNet Probability). For our filter in row 3 in Figure 3 the expected number of cases that we could obtain by pure chance that would match or exceed the \$6552 is 6552 x 2.61 10^{-4} = 0.171. This is much less than one case so it is improbable that our result was due to pure chance

Results

Table 1 on page 10 below presents a table of the 106 in-sample and out-of-sample windows, the selected optimum parameters and the weekly out-of-sample results using the filter described above. The out-of-sample results are for 100 shares of SPY and the net figures use a \$4 round trip trade cost and slippage.

Figure 3 presents a graph of the equity and net equity curves generated by using the filter on the 106 weeks ending 4/6/12 to 4/11/14. 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.

Figure 4 30 minute bar chart of SPY from 4/7/14-4/11/2014 with the Walk Forward Out-Of-Sample strategy inputs for the SPY Parabxot Strategy

Figure 5 Partial output of the Walk Forward Metric Performance Explorer (WFME) Run on the 106 IS/OOS files of the SPY 30min bars Parabxot Strategy

Discussion of System Performance

In Figure 5 Row 3 of the spreadsheet filter output are some statistics that are of interest for our filter. **BE** is the breakeven 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 after that number of weeks will be greater than zero. Whenever you have a random process that has a positive average and a standard deviation it can take many of paths. We want to know how many weeks we would have to trade so that at least 98% of those paths produce above zero profits. BE is 43 weeks for this filter. Another interesting statistic is **Blw**. Blw is the maximum number of weeks the OSNP equity curve failed to make a new high. Blw is 17 weeks for this filter. This means that 17 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 ***start, inc, max, xo and xpr*** 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 ***xo*** changes from zero to 0.5. When the data gets very noisy with a lot of spurious price movements, it's better to have a larger ***xo*** filtering out the noisy data. During other times when the noise level is not as much xo is smaller either 0 or 0.1. This is what the filter is doing. When there is a lot of noise in the in-sample section it switches to the a larger xo and xpr. When the noise level is lower in the in-sample section, it switches to the lower values of xo and xpr..

Using this filter, the strategy was able to generate $6,552 net equity after commissions and slippage trading 100 shares of SPY for 106 weeks. Note $4 roundtrip commission and slippage was subtracted from each. The largest losing week was -$611 and the largest drawdown was -$982. The longest time between new equity highs was 17 weeks.

In observing Table 1 we can see that this strategy and filter made trades from a low of one trade/week to a high of 8 trades/week with an average of 3.4 trades/week. The strategy seemed to wait for really strong trends and then initiate a buy or sell. In observing the chart from 4/11/2014 we can see the strategy did real well in following the trend when there was big trend action and got whipsawed during back and forth price action.

We can see from Figure 5 that the average trade for 100 shares was $22.4 and 60% of the trades were positive. The net average trade after slippage and commissions was $22.4-$4=$18.4 .

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References

Wilder, J. Welles, *New Concepts in Technical Trading Systems*, Trend Research, 1978.
Meyers, Dennis , "Modifying The Parabolic Stop And Reversal", *Technical Analysis of Stocks & Commodities*, April 1995

Figure 1 Parabolic with the 30 min bar chart of SPY

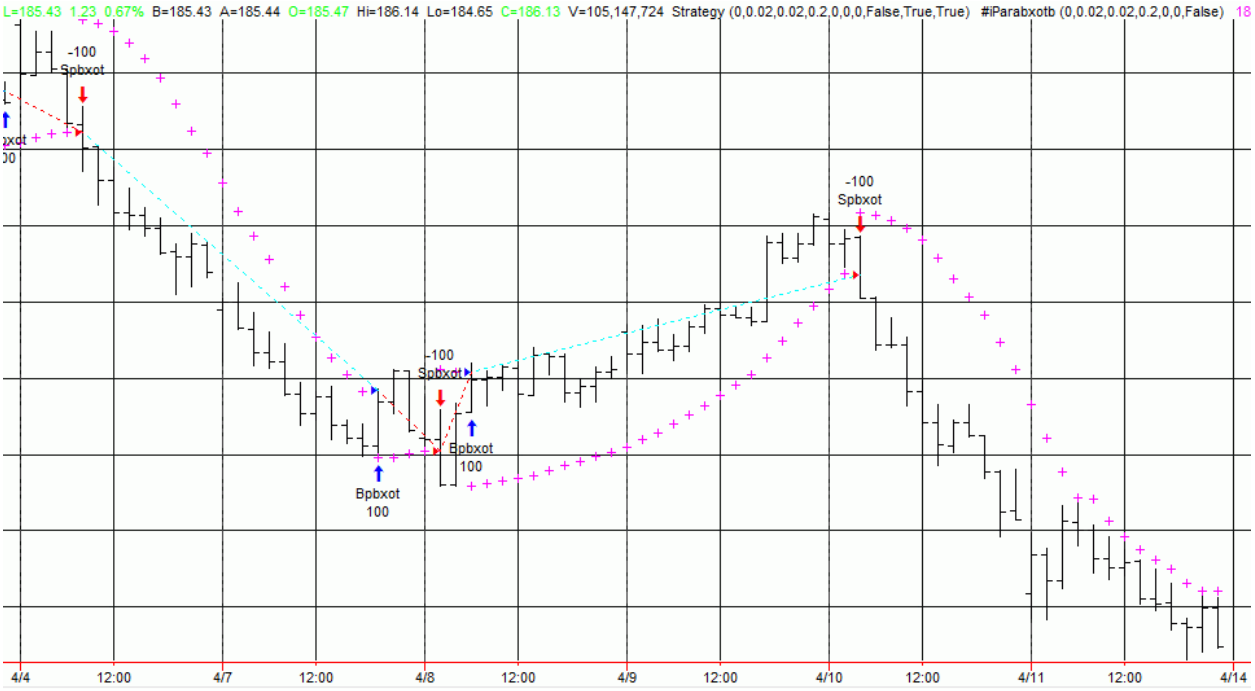

FIGURE 2 SPY Parabolic Stop Loss Calculation

Date	Time	high	low	close	AF	Position	sar
4/3/2014	1000	188.80	188.51	188.79	0.02	SHORT	189.19
4/3/2014	1030	188.81	188.55	188.59	0.02	SHORT	189.18
4/3/2014	1100	188.66	188.44	188.51	0.04	SHORT	189.16
4/3/2014	1130	188.66	188.39	188.51	0.06	SHORT	189.13
4/3/2014	1200	188.51	188.26	188.35	0.08	SHORT	189.08
4/3/2014	1230	188.62	188.31	188.61	0.08	SHORT	189.01
4/3/2014	1300	188.76	188.51	188.55	0.08	SHORT	188.95
4/3/2014	1330	188.62	188.38	188.40	0.08	SHORT	188.9
4/3/2014	1400	188.40	188.05	188.39	0.10	SHORT	188.83
4/3/2014	1430	188.66	188.35	188.65	0.10	SHORT	188.75
4/3/2014	1500	188.89	188.60	188.61	0.02	LONG	188.05
4/4/2014	900	189.70	188.66	188.98	0.04	LONG	188.08
4/4/2014	930	189.55	188.97	189.28	0.04	LONG	188.15
4/4/2014	1000	189.54	189.00	189.06	0.04	LONG	188.21
4/4/2014	1030	189.06	188.22	188.34	0.04	LONG	188.22
4/4/2014	1100	188.57	187.72	188.02	0.02	SHORT	189.7
4/4/2014	1130	188.04	187.27	187.60	0.04	SHORT	189.65
4/4/2014	1200	187.77	187.02	187.17	0.06	SHORT	189.55
4/4/2014	1230	187.49	186.95	187.13	0.08	SHORT	189.39
4/4/2014	1300	187.23	186.86	186.96	0.10	SHORT	189.19
4/4/2014	1330	187.10	186.62	186.65	0.12	SHORT	188.93
4/4/2014	1400	186.76	186.10	186.59	0.14	SHORT	188.59
4/4/2014	1430	186.89	186.20	186.77	0.14	SHORT	188.24
4/4/2014	1500	186.79	186.32	186.39	0.14	SHORT	187.94
4/7/2014	900	186.05	185.22	186.00	0.16	SHORT	187.56
4/7/2014	930	186.26	185.64	185.65	0.16	SHORT	187.19
4/7/2014	1000	185.87	185.17	185.33	0.18	SHORT	186.86
4/7/2014	1030	185.60	185.13	185.21	0.20	SHORT	186.55
4/7/2014	1100	185.45	184.78	184.79	0.20	SHORT	186.2
4/7/2014	1130	184.94	184.38	184.54	0.20	SHORT	185.83
4/7/2014	1200	184.83	184.46	184.76	0.20	SHORT	185.54
4/7/2014	1230	184.90	184.19	184.39	0.20	SHORT	185.27
4/7/2014	1300	184.45	184.14	184.21	0.20	SHORT	185.05
4/7/2014	1330	184.40	183.97	184.12	0.20	SHORT	184.83
4/7/2014	1400	184.86	183.96	184.69	0.02	LONG	183.96
4/7/2014	1430	185.11	184.53	185.10	0.04	LONG	183.96
4/7/2014	1500	185.10	184.30	184.31	0.04	LONG	184.01
4/8/2014	900	184.76	184.06	184.20	0.04	LONG	184.05
4/8/2014	930	184.59	183.59	183.60	0.02	SHORT	185.11
4/8/2014	1000	184.68	183.59	184.54	0.02	SHORT	185.08
4/8/2014	1030	185.20	184.55	184.98	0.02	LONG	183.59
4/8/2014	1100	185.09	184.64	185.02	0.02	LONG	183.62
4/8/2014	1130	185.16	184.84	185.14	0.02	LONG	183.65
4/8/2014	1200	185.17	184.77	184.79	0.02	LONG	183.68
4/8/2014	1230	185.40	184.78	185.30	0.04	LONG	183.72
4/8/2014	1300	185.33	185.05	185.28	0.04	LONG	183.79
4/8/2014	1330	185.32	184.69	184.81	0.04	LONG	183.85
4/8/2014	1400	185.00	184.62	184.90	0.04	LONG	183.91
4/8/2014	1430	185.15	184.69	185.08	0.04	LONG	183.97
4/8/2014	1500	185.28	185.00	185.11	0.04	LONG	184.03

Table 1 Walk Forward Out-Of-Sample Performance Summary for SPY 30min bar Parabxot Strategy

SPY-30 min bars 4/6/2012 - 4/11/2014. The input values *start, inc max, xo, xprc* are the values found from applying the filter to the in-sample section optimization runs.

Filter= Bottom 20 mLTr then maximum eqR2

osnp = Weekly Out-of-sample gross profit in $
Equity = Running Sum of weekly out-of-sample gross profits $
NOnp$4 = Weekly Out-Of-Sample Net Profit in $ = **osnp-ont*4**.
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.
start= parabolic start AF
inc = AF increment
max= maximum AF
xo= The noise crossover amount. The amount the price has to break above or below the parabolic curve to issue a buy or sell signal.
Xprc = the amount to add or substrate to the starting value of the stop loss when a new buy or sell is initiated.
Note: Blank rows indicate that no out-of-sample trades were made that week

In-Sample Dates			Out-Of-Sample Dates			osnp	Equity	Nonp$4	NetEq	ollt	odd	ont	start	inc	max	xo	xprc
3/1/2012	to	3/30/2012	4/2/2012	to	4/6/2012	176	176	174	174	0	0	1	0.02	0.04	0.08	0.3	0.1
3/8/2012	to	4/6/2012	4/9/2012	to	4/13/2012	315	491	311	485	0	0	2	0.02	0.03	0.08	0.3	0.2
3/15/2012	to	4/13/2012	4/16/2012	to	4/20/2012	(84)	407	(92)	393	-210	-245	4	0.01	0.05	0.12	0.4	0.3
3/22/2012	to	4/20/2012	4/23/2012	to	4/27/2012	436	843	432	825	0	0	2	0.02	0.02	0.22	0.4	0.3
3/29/2012	to	4/27/2012	4/30/2012	to	5/4/2012	127	970	121	946	-66	-122	3	0.01	0.03	0.14	0.4	0.6
4/5/2012	to	5/4/2012	5/7/2012	to	5/11/2012	(555)	415	(567)	379	-253	-650	6	0.01	0.05	0.3	0.2	0.1
4/12/2012	to	5/11/2012	5/14/2012	to	5/18/2012	355	770	351	730	-109	-109	2	0.01	0.03	0.1	0	0.6
4/19/2012	to	5/18/2012	5/21/2012	to	5/25/2012	174	944	164	894	-159	-159	5	0.02	0.05	0.12	0.1	0.6
4/26/2012	to	5/25/2012	5/28/2012	to	6/1/2012	(110)	834	(118)	776	-191	-288	4	0.01	0.04	0.26	0.2	0.5
5/3/2012	to	6/1/2012	6/4/2012	to	6/8/2012	307	1141	301	1077	-203	-203	3	0.01	0.03	0.18	0.5	0.6
5/10/2012	to	6/8/2012	6/11/2012	to	6/15/2012	(101)	1040	(117)	960	-68	-139	8	0.02	0.05	0.3	0.1	0
5/17/2012	to	6/15/2012	6/18/2012	to	6/22/2012	148	1188	138	1098	-135	-165	5	0.01	0.05	0.16	0.1	0
5/24/2012	to	6/22/2012	6/25/2012	to	6/29/2012	522	1710	514	1612	-117	-117	4	0.02	0.05	0.3	0.2	0.4
5/31/2012	to	6/29/2012	7/2/2012	to	7/6/2012	236	1946	232	1844	0	0	2	0.02	0.05	0.3	0.2	0.4
6/7/2012	to	7/6/2012	7/9/2012	to	7/13/2012	(96)	1850	(104)	1740	-143	-273	4	0.01	0.04	0.12	0.1	0.3
6/14/2012	to	7/13/2012	7/16/2012	to	7/20/2012	18	1868	12	1752	-78	-78	3	0.02	0.05	0.08	0.1	0.5
6/21/2012	to	7/20/2012	7/23/2012	to	7/27/2012	340	2208	334	2086	-156	-207	3	0.02	0.05	0.08	0.1	0.5
6/28/2012	to	7/27/2012	7/30/2012	to	8/3/2012	(196)	2012	(204)	1882	-114	-240	4	0.01	0.05	0.08	0	0.6
7/5/2012	to	8/3/2012	8/6/2012	to	8/10/2012	(48)	1964	(50)	1832	0	0	1	0.01	0.01	0.14	0.2	0.6
7/12/2012	to	8/10/2012	8/13/2012	to	8/17/2012	44	2008	42	1874	0	0	1	0.01	0.01	0.06	0.2	0.5
7/19/2012	to	8/17/2012	8/20/2012	to	8/24/2012	(56)	1952	(62)	1812	-97	-152	3	0.01	0.01	0.14	0	0.5
7/26/2012	to	8/24/2012	8/27/2012	to	8/31/2012	(74)	1878	(84)	1728	-88	-88	5	0.02	0.05	0.2	0	0.3
8/2/2012	to	8/31/2012	9/3/2012	to	9/7/2012	307	2185	303	2031	-12	-12	2	0.02	0.04	0.22	0	0.2
8/9/2012	to	9/7/2012	9/10/2012	to	9/14/2012	190	2375	180	2211	-20	-20	5	0.02	0.05	0.12	0	0.3
8/16/2012	to	9/14/2012	9/17/2012	to	9/21/2012	53	2428	45	2256	-53	-53	4	0.02	0.05	0.12	0	0.3
8/23/2012	to	9/21/2012	9/24/2012	to	9/28/2012	90	2518	82	2338	-151	-151	4	0.01	0.05	0.14	0	0.4
8/30/2012	to	9/28/2012	10/1/2012	to	10/5/2012	(121)	2397	(133)	2205	-84	-226	6	0.01	0.05	0.2	0	0.3
9/6/2012	to	10/5/2012	10/8/2012	to	10/12/2012	258	2655	248	2453	-35	-35	5	0.01	0.05	0.3	0	0.3
9/13/2012	to	10/12/2012	10/15/2012	to	10/19/2012	453	3108	451	2904	0	0	1	0.01	0.01	0.08	0.5	0.6
9/20/2012	to	10/19/2012	10/22/2012	to	10/26/2012	(257)	2851	(261)	2643	-231	-231	2	0.01	0.01	0.14	0.5	0.6
9/27/2012	to	10/26/2012	10/29/2012	to	11/2/2012	117	2968	115	2758	0	0	1	0.01	0.01	0.06	0.5	0.5
10/4/2012	to	11/2/2012	11/5/2012	to	11/9/2012	73	3041	69	2827	-130	-164	2	0.01	0.05	0.06	0.3	0.6

10/11/2012	to	11/9/2012	11/12/2012	to	11/16/2012	(6)	3035	(12)	2815	-92	-92	3	0.01	0.05	0.06	0.2	0.6
10/18/2012	to	11/16/2012	11/19/2012	to	11/23/2012	142	3177	138	2953	-166	-166	2	0.01	0.05	0.26	0.5	0.1
10/25/2012	to	11/23/2012	11/26/2012	to	11/30/2012	(113)	3064	(125)	2828	-79	-184	6	0.02	0.04	0.3	0	0.4
11/1/2012	to	11/30/2012	12/3/2012	to	12/7/2012	(45)	3019	(53)	2775	-54	-105	4	0.01	0.05	0.12	0	0.6
11/8/2012	to	12/7/2012	12/10/2012	to	12/14/2012	(101)	2918	(113)	2662	-96	-153	6	0.02	0.05	0.18	0	0.4
11/15/2012	to	12/14/2012	12/17/2012	to	12/21/2012	246	3164	242	2904	0	0	2	0.01	0.02	0.06	0.2	0.1
11/22/2012	to	12/21/2012	12/24/2012	to	12/28/2012	50	3214	46	2950	-118	-118	2	0.01	0.02	0.06	0.2	0.1
11/29/2012	to	12/28/2012	12/31/2012	to	1/4/2013	128	3342	124	3074	-259	-429	2	0.01	0.01	0.06	0.1	0.5
12/6/2012	to	1/4/2013	1/7/2013	to	1/11/2013	(72)	3270	(76)	2998	-70	-70	2	0.01	0.01	0.06	0.2	0.5
12/13/2012	to	1/11/2013	1/14/2013	to	1/18/2013	(36)	3234	(40)	2958	-81	-81	2	0.01	0.01	0.14	0.1	0.6
12/20/2012	to	1/18/2013	1/21/2013	to	1/25/2013	16	3250	12	2970	-85	-85	2	0.01	0.04	0.3	0.1	0.4
12/27/2012	to	1/25/2013	1/28/2013	to	2/1/2013	8	3258	(2)	2968	-74	-105	5	0.01	0.04	0.3	0.1	0.4
1/3/2013	to	2/1/2013	2/4/2013	to	2/8/2013	(26)	3232	(34)	2934	-37	-37	4	0.01	0.04	0.2	0.1	0.4
1/10/2013	to	2/8/2013	2/11/2013	to	2/15/2013	(23)	3209	(33)	2901	-52	-92	5	0.02	0.04	0.26	0.1	0.3
1/17/2013	to	2/15/2013	2/18/2013	to	2/22/2013	433	3642	427	3328	-9	-9	3	0.02	0.05	0.2	0	0.5
1/24/2013	to	2/22/2013	2/25/2013	to	3/1/2013	437	4079	429	3757	-31	-31	4	0.01	0.05	0.22	0	0.6
1/31/2013	to	3/1/2013	3/4/2013	to	3/8/2013	56	4135	48	3805	-126	-126	4	0.02	0.05	0.2	0	0.5
2/7/2013	to	3/8/2013	3/11/2013	to	3/15/2013	110	4245	98	3903	-145	-145	6	0.02	0.05	0.18	0	0.4
2/14/2013	to	3/15/2013	3/18/2013	to	3/22/2013	(524)	3721	(534)	3369	-162	-593	5	0.02	0.02	0.22	0	0.5
2/21/2013	to	3/22/2013	3/25/2013	to	3/29/2013	(238)	3483	(244)	3125	-139	-355	3	0.02	0.02	0.1	0.2	0
2/28/2013	to	3/29/2013	4/1/2013	to	4/5/2013	(34)	3449	(38)	3087	0	0	2	0.01	0.01	0.08	0.5	0.6
3/7/2013	to	4/5/2013	4/8/2013	to	4/12/2013	180	3629	176	3263	0	0	2	0.01	0.01	0.06	0.5	0
3/14/2013	to	4/12/2013	4/15/2013	to	4/19/2013	364	3993	362	3625	0	0	1	0.01	0.01	0.06	0.6	0.2
3/21/2013	to	4/19/2013	4/22/2013	to	4/26/2013	279	4272	277	3902	0	0	1	0.01	0.01	0.06	0.6	0
3/28/2013	to	4/26/2013	4/29/2013	to	5/3/2013	32	4304	30	3932	0	0	1	0.01	0.01	0.06	0.5	0.2
4/4/2013	to	5/3/2013	5/6/2013	to	5/10/2013	129	4433	127	4059	0	0	1	0.01	0.01	0.24	0.3	0.1
4/11/2013	to	5/10/2013	5/13/2013	to	5/17/2013	(48)	4385	(60)	3999	-89	-251	6	0.01	0.03	0.3	0	0
4/18/2013	to	5/17/2013	5/20/2013	to	5/24/2013	339	4724	335	4334	0	0	2	0.02	0.04	0.06	0	0.6
4/25/2013	to	5/24/2013	5/27/2013	to	5/31/2013	400	5124	394	4728	0	0	3	0.01	0.03	0.28	0.1	0.5
5/2/2013	to	5/31/2013	6/3/2013	to	6/7/2013	135	5259	125	4853	-179	-308	5	0.01	0.03	0.28	0.1	0.5
5/9/2013	to	6/7/2013	6/10/2013	to	6/14/2013	(29)	5230	(41)	4812	-172	-172	6	0.02	0.03	0.26	0.1	0.4
5/16/2013	to	6/14/2013	6/17/2013	to	6/21/2013	259	5489	247	5059	-180	-345	6	0.02	0.05	0.18	0.4	0.1
5/23/2013	to	6/21/2013	6/24/2013	to	6/28/2013	533	6022	529	5588	0	0	2	0.01	0.01	0.18	0.5	0.5
5/30/2013	to	6/28/2013	7/1/2013	to	7/5/2013	(170)	5852	(172)	5416	0	0	1	0.01	0.02	0.06	0.4	0.5
6/6/2013	to	7/5/2013	7/8/2013	to	7/12/2013	470	6322	468	5884	0	0	1	0.02	0.01	0.2	0.5	0.5
6/13/2013	to	7/12/2013	7/15/2013	to	7/19/2013	49	6371	41	5925	-43	-43	4	0.01	0.04	0.28	0.1	0.1
6/20/2013	to	7/19/2013	7/22/2013	to	7/26/2013	(142)	6229	(152)	5773	-97	-218	5	0.02	0.03	0.3	0.2	0
6/27/2013	to	7/26/2013	7/29/2013	to	8/2/2013	(183)	6046	(189)	5584	-178	-344	3	0.01	0.03	0.1	0	0.5
7/4/2013	to	8/2/2013	8/5/2013	to	8/9/2013	(128)	5918	(142)	5442	-120	-207	7	0.01	0.05	0.12	0	0.1
7/11/2013	to	8/9/2013	8/12/2013	to	8/16/2013	173	6091	171	5613	0	0	1	0.02	0.01	0.24	0.3	0
7/18/2013	to	8/16/2013	8/19/2013	to	8/23/2013	82	6173	80	5693	0	0	1	0.02	0.04	0.06	0.6	0
7/25/2013	to	8/23/2013	8/26/2013	to	8/30/2013	260	6433	252	5945	-171	-214	4	0.01	0.04	0.3	0.2	0.5
8/1/2013	to	8/30/2013	9/2/2013	to	9/6/2013	(611)	5822	(621)	5324	-197	-469	5	0.02	0.04	0.3	0.1	0
8/8/2013	to	9/6/2013	9/9/2013	to	9/13/2013	273	6095	269	5593	-32	-32	2	0.02	0.02	0.08	0	0
8/15/2013	to	9/13/2013	9/16/2013	to	9/20/2013	374	6469	368	5961	-43	-43	3	0.02	0.03	0.08	0	0
8/22/2013	to	9/20/2013	9/23/2013	to	9/27/2013	(189)	6280	(197)	5764	-124	-249	4	0.01	0.01	0.14	0	0.1
8/29/2013	to	9/27/2013	9/30/2013	to	10/4/2013	(396)	5884	(410)	5354	-161	-556	7	0.02	0.04	0.08	0	0.1
9/5/2013	to	10/4/2013	10/7/2013	to	10/11/2013	432	6316	426	5780	-91	-91	3	0.01	0.01	0.14	0	0.2
9/12/2013	to	10/11/2013	10/14/2013	to	10/18/2013	263	6579	255	6035	-65	-65	4	0.01	0.03	0.3	0	0.5
9/19/2013	to	10/18/2013	10/21/2013	to	10/25/2013	(73)	6506	(79)	5956	-77	-188	3	0.02	0.02	0.18	0	0.5
9/26/2013	to	10/25/2013	10/28/2013	to	11/1/2013	(309)	6197	(323)	5633	-100	-351	7	0.02	0.03	0.22	0	0.4
10/3/2013	to	11/1/2013	11/4/2013	to	11/8/2013	(310)	5887	(318)	5315	-130	-420	4	0.02	0.02	0.08	0.2	0.5
10/10/2013	to	11/8/2013	11/11/2013	to	11/15/2013	97	5984	93	5408	-93	-93	2	0.02	0.05	0.14	0.6	0.2
10/17/2013	to	11/15/2013	11/18/2013	to	11/22/2013	(192)	5792	(200)	5208	-120	-251	4	0.02	0.05	0.14	0.6	0
10/24/2013	to	11/22/2013	11/25/2013	to	11/29/2013	(9)	5783	(11)	5197	0	0	1	0.02	0.04	0.14	0.6	0.2
10/31/2013	to	11/29/2013	12/2/2013	to	12/6/2013	120	5903	118	5315	0	0	1	0.01	0.05	0.12	0.5	0.6

11/7/2013	to	12/6/2013	12/9/2013	to	12/13/2013	247	6150	243	5558	0	0	2	0.01	0.05	0.12	0.5	0.6
11/14/2013	to	12/13/2013	12/16/2013	to	12/20/2013	(289)	5861	(295)	5263	-233	-314	3	0.01	0.01	0.08	0.3	0.4
11/21/2013	to	12/20/2013	12/23/2013	to	12/27/2013	57	5918	55	5318	0	0	1	0.01	0.04	0.12	0.3	0.5
11/28/2013	to	12/27/2013	12/30/2013	to	1/3/2014	(106)	5812	(114)	5204	-37	-49	4	0.01	0.05	0.06	0	0.1
12/5/2013	to	1/3/2014	1/6/2014	to	1/10/2014	(215)	5597	(219)	4985	-171	-272	2	0.01	0.03	0.12	0.2	0.6
12/12/2013	to	1/10/2014	1/13/2014	to	1/17/2014	184	5781	174	5159	-69	-69	5	0.02	0.03	0.3	0	0.5
12/19/2013	to	1/17/2014	1/20/2014	to	1/24/2014	473	6254	471	5630	0	0	1	0.02	0.01	0.24	0.5	0.2
12/26/2013	to	1/24/2014	1/27/2014	to	1/31/2014	(398)	5856	(406)	5224	-203	-495	4	0.02	0.01	0.24	0.5	0.2
1/2/2014	to	1/31/2014	2/3/2014	to	2/7/2014	667	6523	665	5889	0	0	1	0.01	0.01	0.06	0.3	0.6
1/9/2014	to	2/7/2014	2/10/2014	to	2/14/2014	(81)	6442	(85)	5804	-256	-256	2	0.01	0.02	0.14	0.6	0.1
1/16/2014	to	2/14/2014	2/17/2014	to	2/21/2014	251	6693	243	6047	-46	-46	4	0.01	0.05	0.3	0	0.6
1/23/2014	to	2/21/2014	2/24/2014	to	2/28/2014	5	6698	(7)	6040	-68	-131	6	0.01	0.05	0.3	0	0.6
1/30/2014	to	2/28/2014	3/3/2014	to	3/7/2014	265	6963	257	6297	-58	-94	4	0.02	0.05	0.12	0	0.1
2/6/2014	to	3/7/2014	3/10/2014	to	3/14/2014	(116)	6847	(130)	6167	-124	-271	7	0.02	0.05	0.12	0	0.1
2/13/2014	to	3/14/2014	3/17/2014	to	3/21/2014	156	7003	142	6309	-102	-102	7	0.02	0.05	0.26	0	0.1
2/20/2014	to	3/21/2014	3/24/2014	to	3/28/2014	253	7256	247	6556	0	0	3	0.02	0.05	0.14	0.2	0.4
2/27/2014	to	3/28/2014	3/31/2014	to	4/4/2014	201	7457	195	6751	-150	-270	3	0.02	0.04	0.06	0	0
3/6/2014	to	4/4/2014	4/7/2014	to	4/11/2014	519	7976	513	7264	0	0	3	0.02	0.04	0.06	0	0

Figure 3 Graph of Net Equity Curve Applying the Walk Forward Filter Each Week On SPY 30min Bar Prices 4/6/12 – 4/11/14

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

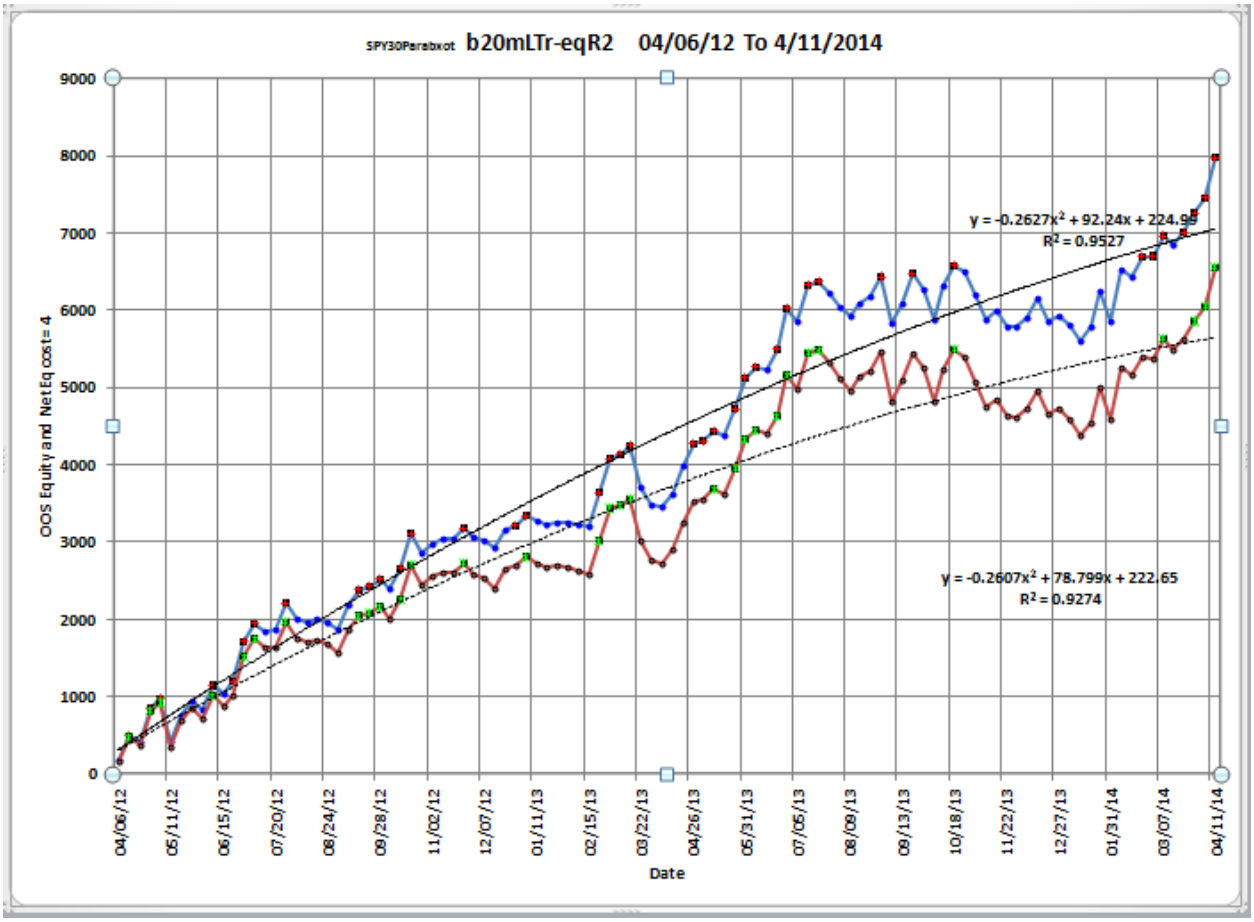

Figure 4 Walk Forward Out-Of-Sample Performance for SPY Parabxot Strategy
30 minute bar chart of SPY from 4/7/14-4/11/2014

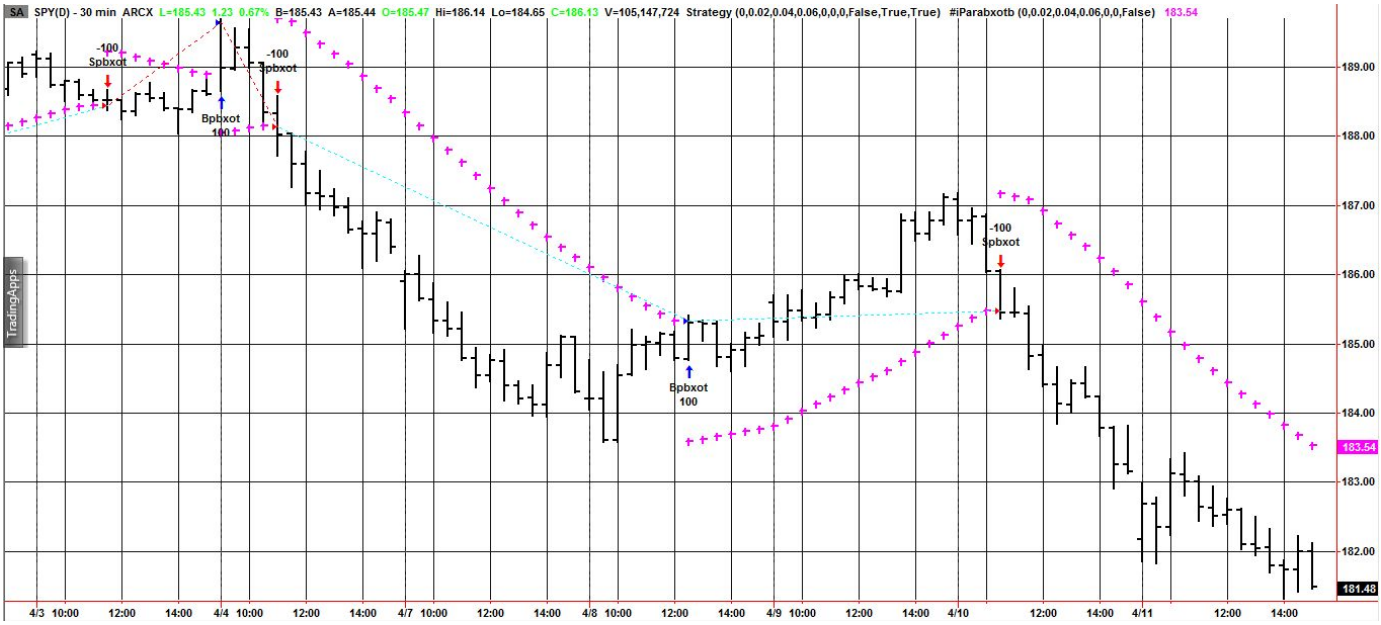

Figure 5 Partial output of the Walk Forward Metric Performance Explorer (WFME) Run on the 106 IS/OOS files of the SPY 30min bars Parabxot Strategy

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	SPY30Parabxot	s04/06/12	e04/11/14	#106	AnyTnp				a408	s1771	f961									c=$ 4	
2	Filter-Metric	tOnp	aOnp	aOTrd	aO#T	B0	%P	t	std	LLp	eqDD	lr	#	eqTrn	eqR2	Dev^2	Blw	BE	eff	tOnpNet	Prob
3	b20mLTr-eqR2	7976	75	22.4	3.4	(0.1)	60	3.12	248	-611	-982	3	106	64	94	492	17	43.5	0.46	6552	2.61E-04
4	b20mLTr-wr	7606	72	19.9	3.6	0.9	60	3.03	244	-581	-840	4	106	61	90	617	18	46.3	0.44	6078	6.83E-04
5	b20mLTr-eq2V	7098	67	21.1	3.2	(0.6)	58	2.81	246	-620	-850	4	106	53	89	572	26	53.8	0.47	5750	1.28E-03

The WFME Filter Output Columns are defined as follows:

Row 1 SPY30Parabxot is the strategy abbreviation, First OOS Week End Date(4/6/12), Last OOS Week End Date(4/11/14), **Number of weeks**(#106) **a**=average of bootstrap random picks. **s**= standard deviation of bootstrap random picks. **f**=number of different filters examined. **c**= round trip slippage and trade cost(c=$4).

Filter = The filter that was run. Row 3 filter **b20mLTr-eqR2**

The b20mLTr-eqR2 filter produced the following average 106 week statistics on row 3.

tOnp = Total out-of-sample(oos) net profit for these 106 weeks.

aOsp = Average oos net profit for the 106 weeks

aOTrd = Average oos profit per trade

aO#T = Average number of oos trades per week

B0 = The 106 week trend of the out-of-sample weekly profits

%P = The percentage of oos weeks that were profitable

t = The student t statistic for the 106 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 106 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.

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.

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

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

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