Tricked by Randomness

With the advent of today's fast computers and technical analysis software finding the best results on past data for any given system using the procedure of optimization has become very easy. Here optimization is defined as the combinatorial search over a range of system parameter values on a fixed set of data for the cases that produce the best system net profits or some other selected performance variable. Unfortunately the parameters that produce the best results on past data don't necessarily produce good results in real time. Why is that? Optimization is performed on price data over some fixed time period with a fixed number of bars. The price data consists of repeatable price dynamics (if any) and random price movements called noise. The optimization process curve fits the price dynamics ***and*** the noise. The noise process will not be repeated in the same way in the out-of-sample data or real time. The profits on out-of-sample data from choosing the parameters that generate the best net profits or the best profit factors from the curve fit on the test data will usually disappear. In addition it can be seen that if the optimization process fits the noise extremely well and not the signal over the fixed number of bars examined, then the system will perform poorly in real time.

Optimization and Curve Fitting

All systems are curve fitted in some fashion. Curve fitting can be by computer or by astute observation...it's the same. One takes a fixed time data sample called the test data and tries to get some system, or set of defined rules to work on it either by computer or by observing how things work in that time period. It's almost impossible not to get a good curve fit with almost any indicator over some fixed time sample! The various mathematical statistics derived from the system on the test data only tell you how well you've fitted the test data *not how well the system will perform in the future.* The key here is to determine if the curve fitted system and/or indicator will work on data it has never been tested on, namely out-of-sample data.

To illustrate these points we will use a breakout system called the "Noise Channel Breakout System". Here we will apply the Noise Channel Breakout System to S&P 500 5min bar futures and examine the relationship between various optimization performance parameters and out-of-sample net profit performance.

The Noise Channel Breakout System

The system used here is fairly simple and effective. Intraday data has a high noise content. What this means is that there are many random price movements that look like they are significant but turn out to be false alarms. Without some kind of filter, the losses created by the buy and sells signals generated by the random price movements could completely overwhelm the system. In order to help filter out the random signals, a noise filter, with the symbol *xo*, will be added to a simple breakout system.

The Noise Channel Breakout System is defined as follows:

<u>Buy Rule:</u>

If the SP crosses above the highest high price of the SP of the last ***nhi*** bars by an amount greater then or equal to ***xo***, **then** buy the SP at market. In addition, when short, and when calculating the highest high price (hhp), that hhp cannot be higher than the previously calculated hhp as the ***nhi*** lookback period moves forward and previous highs are dropped out of the lookback window. In other words when short the hhp can only stay the same or go lower...it cannot go higher.

Sell Rule:

If the SP crosses below the lowest low price of the SP of last ***nlo*** bars minus by an amount equal to ***xo*** or greater, **then** sell the SP at market. In addition, when long and when calculating the lowest low price (llp), that llp cannot be lower than the previous calculated llp as the nlo lookback period moves forward and previous lows are dropped out of the lookback window. In other words when long the llp can only stay the same or go higher...it cannot go lower.

S&P 500 Data

The test data section consists of 4 weeks of S&P Sep/2000 5min bars from June 28 2000 to July 28, 2000. We will use July 31, 2000 through August 4, 2000 as the out-of-sample section to see how the system parameters and performance variables derived in the test section perform.

Finding The System Parameters Using Optimization

There are three system parameters *nhi, nlo* and *xo*. We will use TradeStation's optimization module and vary the parameters over the following ranges: nhi from 6 to 50 in steps of 2, nlo from 6 to 50 in steps of 2 and xo from 0.1 to 1.9 in steps of 0.2 for a total of 5290 cases. We will have TradeStation save the following system performance statistics for each case: Net Profit (NP), Number of Trades (#T), percent profitable (%P) Profit Factor (PF), Maximum Drawdown (DD), Maximum wins in a row (Wr), Maximum Losses in a row(Lr), Largest Losing Trade(LLT), Average Wining Bars(aWB), and Average Losing Bars(aLB). In addition we will have TradeStation subtract $100 for slippage and commissions from each trade.

Results

Table 1 presents a table of the best twenty cases ranked by Net Profit(NP). Next to the NP column, the out-of-sample net profit (OSNP) column was inserted. Recall the net profit numbers are calculated for the period of 6/28/2000 through 7/28/2000. The out-of-sample net profit (OSNP) is separately calculated for each case from the period outside this test period namely, 7/31/2000 to 8/4/2000. Using Excel's cut and paste, the out-of-sample net profit column was inserted into the column next to the test section Net Profit for easy comparison.

Figure 1 presents a chart of the S&P 500 with the buy and sell signals generated from the best net profits parameters in Table 1. As can be seen from the chart the buy and sell signals from the best net profit curve fit look great. Observing this type of performance on past data is how we get hoodwinked by randomness.

However, as we can observe from Table 1, Net Profit in this example is not a good criteria for choosing parameters that will perform well in the future. The out-of-sample profits are mostly negative. The few cases of positive out-of-sample net profits seem randomly distributed and don't seem to have any distinguishing features with respect to the other statistics.

Figure 2 presents a 3D Histogram of Net Profits vs Out-of-Sample Net profits. As can be seen from the histogram the out-of-sample profit gains seem to be evenly distributed across all values, both plus and minus, of Net Profits. This means that for this system net profits is not a good selection criteria for selecting parameters that will produce gains in the out-of-sample period. Of particular note in the histogram is that system net profits greater than $5000 produced the greatest number of out-of-sample losses. This represents curve fitting of random data at it's best. The noise portion of the data did not repeat in the out-of-sample data portion resulting in losses from the parameters that fit the noise portion of the test data and produced large net profits.

The Profit Factor is often promoted as a good selection criteria for selecting parameters that will give good out-of-sample performance. Figure 3 presents a 3D Histogram of the Profit Factor vs Out-of-Sample Net profits. As can be seen from the histogram the out-of-sample profit gains seem to be evenly distributed across both profit factors greater than one and less than one. This means that for this system the profit factor is not a good selection criteria for selecting parameters that will produce gains in the out-of-sample period. Of particular interest is profit factors above 2. These profit factors produces no gains and only losses indicating that high values of profit factor represent the curve fitting of the noise portion of the test data and will not produce good out-of-sample results.

Conclusion

We have shown that when a real system is optimized on real data and the parameters of the system are chosen based on the best net profits or the profit factor, out-of-sample losses are likely to occur. The optimization run produces many parameter cases that have excellent net profits, profit factors and other statistics in the test section but losses in the out-of-sample section. This is how we are hoodwinked by randomness. Just looking at the test section performance gives one the illusion that future profits will occur. However as we have seen from the tables and figures such is not the case. It is rather difficult to separate out the cases that produce out-of-sample profits from losses using the above statistics from the test data section. More sophisticated statistical techniques are needed to combine the various test data window performance statistics in a way that will select cases that produce out-of-sample profits with greater probability than our simple sorting method above.

Table 1 Optimum Parameters - Best 20 Cases Ranked By Net Profit (NP)

Case #	nhi	nlo	xo	NP	OSNP	%P	PF	#T	DD	LWT	LLT	aW/L	Wr	Lr	aWB	aLB
1	20	6	0.7	24750	-14725	48.1	2.02	52	-8225	7150	-1925	2.18	4	7	46	20
2	20	14	0.7	22500	-925	45.5	1.98	44	-6725	7025	-1600	2.37	3	3	56	24
3	22	12	0.3	22300	-7075	44.0	1.90	50	-8575	7150	-2050	2.41	3	4	51	20
4	20	12	0.7	21950	-9825	45.7	1.95	46	-5575	7150	-1675	2.33	3	3	52	23
5	18	6	0.7	21800	-14725	50.0	1.80	58	-9025	6025	-2225	1.80	7	7	42	16
6	22	16	0.1	21700	75	41.7	1.92	48	-5650	7450	-2050	2.68	3	5	56	20
7	22	6	0.3	21600	-12525	41.9	1.75	62	-9250	7150	-2225	2.42	4	7	43	16
8	22	14	0.1	21600	-975	42.3	1.86	52	-7975	7450	-2050	2.53	3	5	50	19
9	20	12	0.3	21550	-7075	40.7	1.76	54	-11125	7150	-1975	2.55	3	5	50	18
10	20	6	0.3	21450	-12525	40.9	1.67	66	-9250	7150	-2225	2.41	4	7	42	14
11	22	6	0.7	20700	-14725	46.2	1.81	52	-8175	7150	-1925	2.11	4	7	47	20
12	18	12	0.7	20550	-9825	48.0	1.85	50	-5500	6025	-1700	2.00	5	3	47	22
13	22	14	0.3	20450	1325	45.8	1.82	48	-6275	7450	-2050	2.15	3	3	51	22
14	20	6	0.5	20200	-13975	44.6	1.70	56	-8225	7150	-2650	2.10	4	7	45	18
15	12	24	0.1	20150	1975	43.8	1.70	48	-8600	8125	-2225	2.18	3	3	49	24
16	24	6	0.7	20050	-14725	46.2	1.77	52	-8175	7150	-1925	2.07	4	7	47	19
17	20	12	0.5	19950	-9075	43.8	1.77	48	-7325	7150	-2650	2.28	3	4	52	22
18	24	12	0.3	19900	-7825	44.0	1.76	50	-8575	7150	-2050	2.24	3	4	51	20
19	20	16	0.1	19850	75	38.5	1.74	52	-8625	7450	-1975	2.78	3	5	52	20
20	12	22	0.1	19700	2225	42.0	1.67	50	-7850	8075	-2225	2.31	3	4	48	23

Figure 1 The S&P 500 with the buy and sell signals generated from the best net profits parameters in Table 1

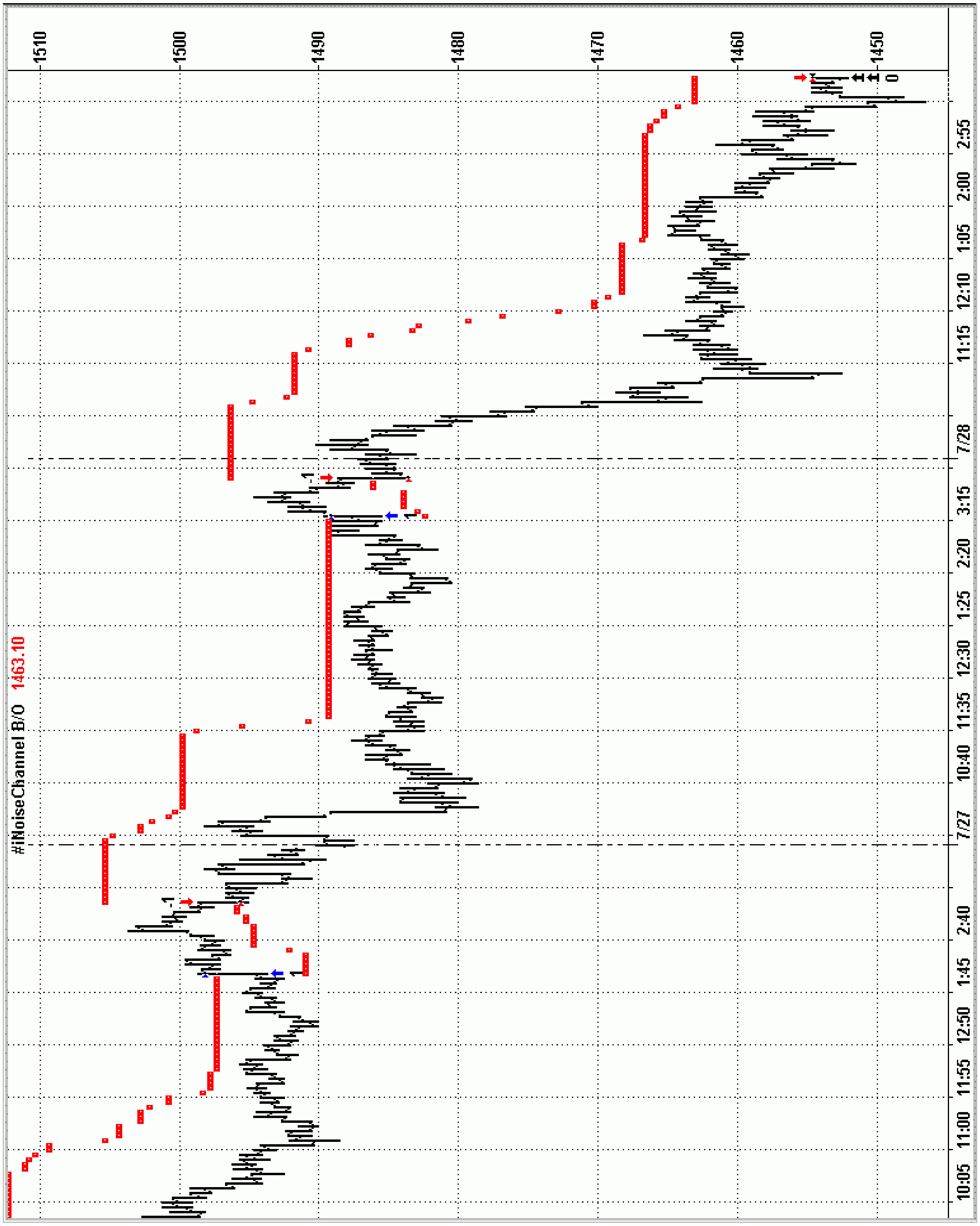

Figure 2 3D Histogram of Net Profits vs Out-of-Sample Net profits.

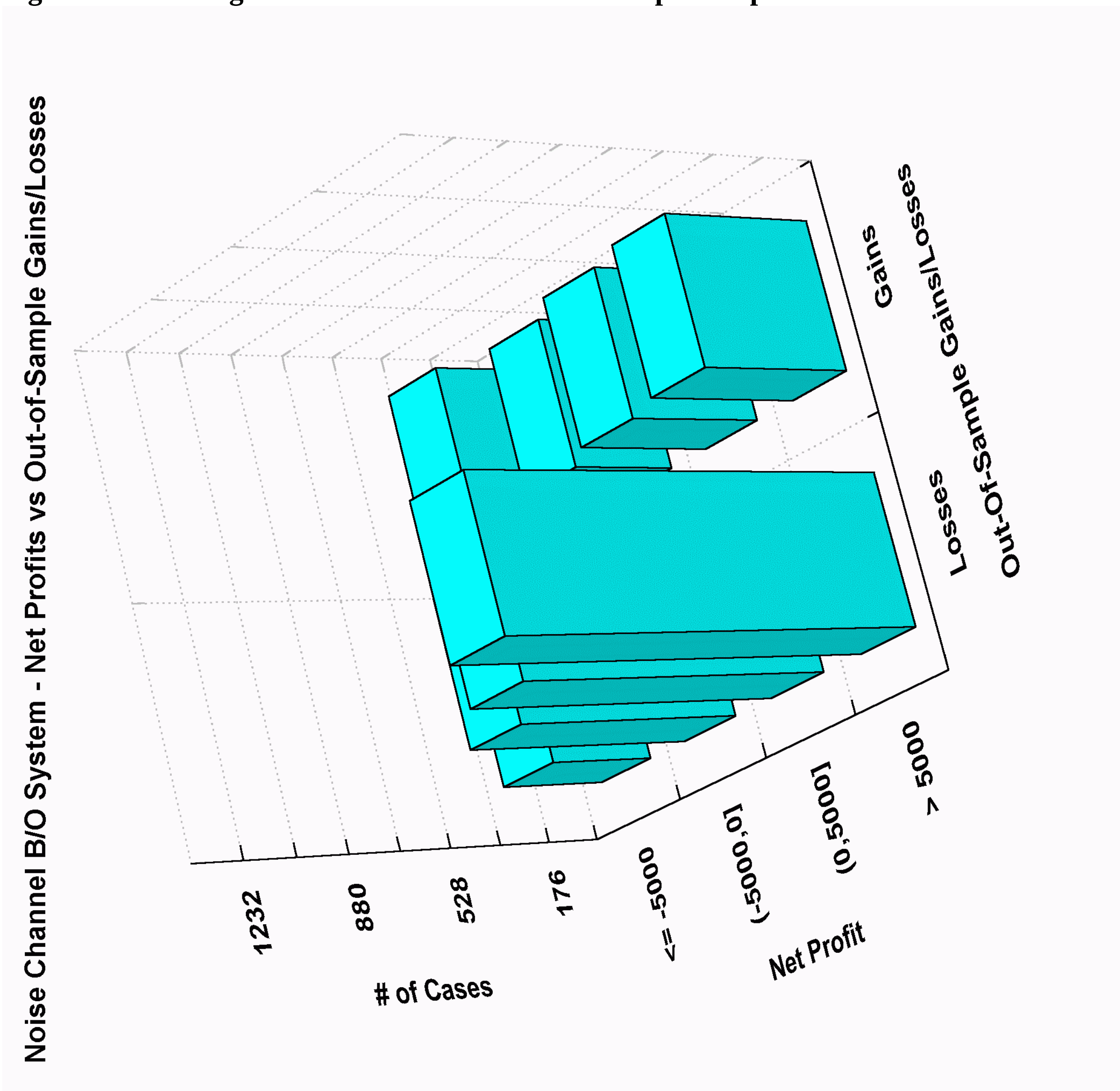

Figure 3   3D Histogram of the Profit Factor vs Out-of-Sample Net profits.