Trading IBM Intraday Using The Fading Memory Polynomial

The Fading Memory Polynomial.

The Fading Memory Polynomial was introduced in a previous article, entitled "The Yen Recursed". In that article we showed how to use a 1st order fading memory polynomial to trade the yen futures on a daily basis. Here we will use a 4th order fading polynomial to trade IBM 1 minute bars on an intraday basis.

The*Fading Memory Polynomial* is a mathematical technique that fits a nth order polynomial to the last ***T*** price bars ***but*** calculates the n coefficients of the polynomial such that the error between the polynomial and the current bar is weighted much higher than the error between the price n bars ago and the value of the polynomial n 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 effecting the polynomial fit as much. As is shown in the sidebar, the most familiar case of the fading memory technique is the 0th order fading memory polynomial popularly known as 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.

As shown in *equation 3* of the Sidebar the solution to the mathematics yields a one day ahead prediction for the value of the next price bar. While the solution for the 0th order fading polynomial yields a unique easy to program formula, unfortunately the 2nd and higher order fading memory polynomials do not.

SIDEBAR Fading Memory Polynomial Mathematics

Consider a time series x(t) where t is an integer value 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 $p(t-\tau)$ where $p(t-0)$ is today, $p(t-1)$ is yesterday, etc., then we can form a error function that consists of the weighted sum of the squared difference between the price series $x(t-\tau)$ and the polynomial $p(t-\tau)$ given by

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

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

It turns out that if we let the nth degree polynomial $p(t-\tau)$ 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 $\mathbf{x(t-\tau)}$ as $\mathbf{x_{est}(t-\tau)}$ and given by the equation

$$\mathbf{x_{est}(t-\tau)=(1-\beta)\Sigma\beta^{k}b_k(t)\Phi_k(\tau) \quad k=0 \text{ to } n \quad (2)}$$

where n is the polynomial degree, $\mathbf{\Phi_k(\tau)}$ are the Meixner polynomials of degree k, and $\mathbf{b_k(t)}$ are the coefficients that minimize the error of equation (1).

For the exact mathematical solutions that produce equation 2 and the mathematical descriptions of the Meixner polynomials please refer to References 1 – 3.

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

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

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

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

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

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

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

which 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 .

END OF SIDEBAR

Fading Memory 4th Order Polynomial System Defined.

The fading memory 4th order polynomial best estimate of the next bars value, $\mathbf{p_{est}(t+1)}$, is constructed at each bar by solving *equation 3* of the Sidebar with ***n***=4.. The $\mathbf{p_{est}(t+1)}$ value is then plotted on the price chart. In general what we will be doing is following the plotted curve of $\mathbf{p_{est}(t+1)}$. 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. For this article 1 minute bars of the IBM will be used for the price series.

Buy Rule:

- **IF** $\mathbf{p_{est}(t+1)}$ has moved up by more than the percentage amount of *pctup* from the lowest low recorded in $\mathbf{p_{est}(t+1)}$ while short then buy at the market.

Sell Rule:

- **IF** $\mathbf{p_{est}(t+1)}$ has moved down by more than the percentage amount *pctdn* from the highest high recorded in $\mathbf{p_{est}(t+1)}$ while long then sell at the market.
-

Exit Rule

Exit all trades 5 minutes before the close of each day.

Note we do not carry any positions overnight. This is done to avoid negative overnight surprises.

Walk Forward Optimization

Walk forward optimization will be used here because of the changing nature of the intraday stock market. Intraday price dynamics are constantly changing due to current economic surprises, events and trader sentiment. Also the time of year changes the nature of intraday markets, such as the seasons, holidays, vacation time, etc. As such, optimizations on intraday data performed 3 months ago may no longer be representative of today's intraday price dynamics.

The walk forward procedure will be applied as follows. A period of 4 weeks of 1min bar data of IBM from December 26th, 2001 through January 25th, 2002, is chosen and system parameter values are found through optimization on this intraday data segment. The parameter values found in the test segment are then applied to the out-of-sample 1 minute intraday bar data following the test segment which in this case is January 28th, 2002 to February 1st , 2002.

Why a 4 weeks of 1min bar data for the intraday data test segment? Why not 2 weeks or 13 weeks? Well the answer is that there is no correct ratio of test data needed to produce good one week intraday out-of-sample results. By experimenting with different window lengths, the four to one ratio seemed to work well. In walk forward testing, enough data is needed to model most of the price dynamics that will be encountered in the out-of-sample segment, but not so much data that when the price dynamics start to change they are swamped by the weight of distant past data price movements that no longer apply. An important unspoken point in walk forward testing is that if you can not get good results in the out-of-sample segments, then the price dynamics cannot be modeled with the system . This means that real time performance will be random using the model. Traders observe this type of random performance (that is it looks great on paper but falls apart in real time) when trying systems based on curve fitting or anecdotal "proof" (looking at 3 or 4 successful cases only) without any out-of-sample testing .

Finding The System Parameters Using Walk Forward Optimization

There are three system parameters to find β, *pctup, and pctdn*.

The best parameters will be defined as those values that give the best Net Profits with the maximum winning bars, minimum losing bars, minimum drawdown, minimum largest losing trades. In addition, the results should be stable, e.g. the profits, wins, and drawdowns should not change by much as the parameters move by a small amount away from their optimum values. As an additional filter in choosing the "best" parameters, only those parameters sets whose maximum consecutive losses were 4 or less were considered. Optimization is defined as the search for the parameter values that give the best results as defined above. The parameter ranges that we will search over are β *[0.92 to 0.99 in steps of 0.005], pctup [0.4 to 1.1 in steps of 0.05], and pctdn [0.4 to 1.1 in steps of 0.05]*. These parameter ranges will produce a total of 3375 cases.

It is not well known, but almost any real time series or even a random time series defined over a fixed number of bars can be curve fitted rather easily. The performance results and the statistical measurements that validate this performance of the curve fit will look excellent giving the false illusion of future profitability. However, the truth is that these excellent performance and associated statistics on the test section in no way validate how the system will perform on data it

has not been optimized on. Only out-of-sample testing, that is testing on data the parameters were not derived on, can determine if the parameters found in the test section have captured the price dynamics. Why is that? This is the nature of a truncated time series. Once you have a time series over a fixed period of time than due to the nature of random processes, also called noise processes, one can almost always find parameters for any system that will give good results over that fixed period of time. If the time series is in fact random or contains a large proportion of noise, than those good results have little probability of continuing outside the test period. Unfortunately we have no way of knowing ahead of time whether we have curve fitted the noise in the price series or some measurable price characteristics. Only optimization and out-of-sample tests over many time periods can determine whether we are being fooled by randomness or our system is measuring real price dynamics.

Results

Figure 1 presents a table of the test window selected optimum parameters for the Fading Memory Polynomial system using the IBM 1 min bar data series.

Start Date	End Date	β	Pctup	Pctdn
12/26/2001	1/26/2002	0.945	0.75%	0.55%

Figure 1 Optimum Parameter Values For Test Data Segment

Figure 2 presents the performance summary using the optimum parameters for the test segment shown in Figure 1.

Figure 3 presents the performance summary of the out-of-sample data segment from 1/28/2002 to 2/1/2002. This performance represents what would have happened in *real time* if one used the parameters found in the test section. Slippage, and commissions are not included.

Figure 4 presents a trade by trade summary from 12/26/2001 to 2/1/2002.

Figures 5A Through 5G present the 1 minute bar charts of IBM with the 4^{th} order Fading Memory Polynomial Curve and all the buy and sell signals from the Out-Of-Sample trade by trade summary of Figure 4 indicated on the charts. Also on these charts the exponential average with $\alpha=(1-\beta)$ is included for comparison. The Fading Memory curve is colored blue while the exponential average curve is colored red.

Discussion of System Performance

As can be observed from the test sample Performance summary in Figure 2 and the out-of-sample performance summary of Figure 3, the out-of-sample performance was comparable to the test sample performance. This comparable performance indicates that 4 weeks in the test section was enough to capture the price dynamics so that the system would perform well in the out-of-sample section. This is not always the case. Many times the underlying price dynamics change abruptly creating loses in the out-of-sample section. However if the test window slides forward every week then the new price dynamics are quickly captured and the out-of-sample profits should return.

Observing trade by trade summary of Figure 4, and the Performance summaries of Figures 2 and 4 we can see that the system performed much better on shorts then on longs. This better short

performance is due to IBM moving mostly downward from 126 to 102 during this period. However, even in this down market for IBM, the longs performance still showed a profit. Maximum trade drawdowns were very low for 1000 shares of IBM. The low drawdowns were probably due to the down trending nature of IBM during the test and out-of-sample sections. From Figures 2 and 3 the average trade (win & loss) was $213 in the test section and $208 in the out-of-sample section. These two equal average trade results indicate stability in the parameter selection.

In examining the charts we can see that the Fading Memory Polynomial curve did a very good job in smoothing the price series while not lagging. The curve had anywhere from a zero bar lag to a 4 bar lag from the major tops and bottoms.

As good as this system looks, please be aware that in order to use this system in real time trading, at least ten to twenty more test and out-of-sample windows from the past would have to be examined to gain confidence that the results above were not due to pure chance.

References:

1. Abramowitz and Stegun, Ed., Handbook of Mathematical Functions, New York: Dover, 1972
2. Meyers, Dennis [1998], "The Yen Recursed", *Stocks & Commodities*, Volume 16: December.
3. Meyers, Dennis [1999], "IBM Cubed", *Stocks & Commodities*, Volume 17: August.

Info on Dennis Meyers

Dennis Meyers (info@MeyersAnalytics.com.) has a doctorate in applied mathematics in engineering. He is a member of the Chicago Board Options Exchange(CBOE), a private trader, and president of Meyers Analytics (www.MeyersAnalytics.com). His firm specializes in consulting for financial institutions and developing publicly available analytical software for traders.

Figure 2 Test Window Performance Summary for IBM 1min Bars
Fading Memory Polynomial System 12/26/2001 - 01/25/2002

Performance Summary: All Trades

Total net profit	$ 13440.000	Open position P/L	$ 0.000
Gross profit	$ 24300.000	Gross loss	$-10860.000
Total # of trades	63	Percent profitable	52%
Number winning trades	33	Number losing trades	30
Largest winning trade	$ 3180.000	Largest losing trade	$ -1010.000
Average winning trade	$ 736.364	Average losing trade	$ -362.000
Ratio avg win/avg loss	2.034	Avg trade(win & loss)	$ 213.333
Max consec. winners	5	Max consec. losers	4
Avg # bars in winners	149	Avg # bars in losers	92
Max intraday drawdown	$ -2560.000		
Profit factor	2.238	Max # contracts held	1

Performance Summary: Long Trades

Total net profit	$ 730.000	Open position P/L	$ 0.000
Gross profit	$ 6300.000	Gross loss	$ -5570.000
Total # of trades	28	Percent profitable	43%
Number winning trades	12	Number losing trades	16
Largest winning trade	$ 1810.000	Largest losing trade	$ -1010.000
Average winning trade	$ 525.000	Average losing trade	$ -348.125
Ratio avg win/avg loss	1.508	Avg trade(win & loss)	$ 26.071
Max consec. winners	5	Max consec. losers	5
Avg # bars in winners	94	Avg # bars in losers	85
Max intraday drawdown	$ -3710.000		
Profit factor	1.131	Max # contracts held	1

Performance Summary: Short Trades

Total net profit	$ 12710.000	Open position P/L	$ 0.000
Gross profit	$ 18000.000	Gross loss	$ -5290.000
Total # of trades	35	Percent profitable	60%
Number winning trades	21	Number losing trades	14
Largest winning trade	$ 3180.000	Largest losing trade	$ -840.000
Average winning trade	$ 857.143	Average losing trade	$ -377.857
Ratio avg win/avg loss	2.268	Avg trade(win & loss)	$ 363.143
Max consec. winners	5	Max consec. losers	4
Avg # bars in winners	180	Avg # bars in losers	101
Max intraday drawdown	$ -1580.000		
Profit factor	3.403	Max # contracts held	1

Figure 3 Out-Of-Sample Performance Summary for IBM 1 min Bars
Fading Memory Polynomial System 01/28/2002 - 02/01/2002

Performance Summary: All Trades

Total net profit	$ 6040.000	Open position P/L	$ 0.000
Gross profit	$ 12980.000	Gross loss	$ -6940.000
Total # of trades	29	Percent profitable	52%
Number winning trades	15	Number losing trades	14
Largest winning trade	$ 2730.000	Largest losing trade	$ -1050.000
Average winning trade	$ 865.333	Average losing trade	$ -495.714
Ratio avg win/avg loss	1.746	Avg trade(win & loss)	$ 208.276
Max consec. winners	3	Max consec. losers	5
Avg # bars in winners	96	Avg # bars in losers	34
Max intraday drawdown	$ -2230.000		
Profit factor	1.870	Max # contracts held	1

Performance Summary: Long Trades

Total net profit	$ 970.000	Open position P/L	$ 0.000
Gross profit	$ 4780.000	Gross loss	$ -3810.000
Total # of trades	16	Percent profitable	44%
Number winning trades	7	Number losing trades	9
Largest winning trade	$ 1380.000	Largest losing trade	$ -1050.000
Average winning trade	$ 682.857	Average losing trade	$ -423.333
Ratio avg win/avg loss	1.613	Avg trade(win & loss)	$ 60.625
Max consec. winners	2	Max consec. losers	4
Avg # bars in winners	70	Avg # bars in losers	30
Max intraday drawdown	$ -2740.000		
Profit factor	1.255	Max # contracts held	1

Performance Summary: Short Trades

Total net profit	$ 5070.000	Open position P/L	$ 0.000
Gross profit	$ 8200.000	Gross loss	$ -3130.000
Total # of trades	13	Percent profitable	62%
Number winning trades	8	Number losing trades	5
Largest winning trade	$ 2730.000	Largest losing trade	$ -950.000
Average winning trade	$ 1025.000	Average losing trade	$ -626.000
Ratio avg win/avg loss	1.637	Avg trade(win & loss)	$ 390.000
Max consec. winners	4	Max consec. losers	3
Avg # bars in winners	119	Avg # bars in losers	40
Max intraday drawdown	$ -2910.000		
Profit factor	2.620	Max # contracts held	1

FIGURE 4 Trade By Trade Summary
IBM 1min Bars FadingMemPoly System 12/26/2001 - 02/01/2002

Entry Date	Entry Time		Entry Price	Exit Date	Exit Time	Exit Price	Bars InTrd	Trade $P&L	Trade %P&L	Trade Max$Pft	Time	Trade Max$DD	Time
1011226:3	1327	Sell	122.95	1011226	1555	122.17	148	$780	0.63%	$780	1555	($550)	1453
1011227:4	932	Sell	122.66	1011227	1001	123.50	29	($840)	-0.68%	$0	932	($840)	1000
1011227:4	1001	Buy	123.50	1011227	1513	123.10	312	($400)	-0.32%	$350	1112	($400)	1513
1011227:4	1513	Sell	123.10	1011227	1555	123.50	42	($400)	-0.32%	$100	1516	($500)	1538
1011228:5	1047	Sell	123.22	1011228	1555	122.74	308	$480	0.39%	$790	1502	($70)	1101
1011231:1	932	Sell	122.75	1011231	1555	121.35	383	$1,400	1.14%	$1,740	1549	($420)	952
1020102:3	932	Sell	120.65	1020102	1111	120.64	99	$10	0.01%	$840	1043	($690)	1004
1020102:3	1111	Buy	120.64	1020102	1203	120.20	52	($440)	-0.36%	$60	1136	($520)	1200
1020102:3	1203	Sell	120.20	1020102	1356	120.50	113	($300)	-0.25%	$400	1324	($490)	1350
1020102:3	1356	Buy	120.50	1020102	1420	120.59	24	$90	0.07%	$620	1403	$0	1356
1020102:3	1420	Sell	120.59	1020102	1540	120.87	80	($280)	-0.23%	$630	1444	($280)	1540
1020102:3	1540	Buy	120.87	1020102	1555	120.89	15	$20	0.02%	$520	1550	($40)	1554
1020103:4	932	Buy	121.41	1020103	1205	122.52	153	$1,110	0.91%	$1,840	1113	($600)	954
1020103:4	1205	Sell	122.52	1020103	1243	122.86	38	($340)	-0.28%	$290	1217	($380)	1238
1020103:4	1243	Buy	122.86	1020103	1555	123.78	192	$920	0.75%	$1,340	1531	($50)	1246
1020104:5	932	Buy	124.05	1020104	1027	124.80	55	$750	0.60%	$1,450	1006	$0	932
1020104:5	1027	Sell	124.80	1020104	1517	125.27	290	($470)	-0.38%	$590	1333	($500)	1514
1020104:5	1517	Buy	125.27	1020104	1555	125.00	38	($270)	-0.22%	$130	1520	($350)	1544
1020107:1	936	Buy	125.64	1020107	1115	125.47	99	($170)	-0.14%	$510	1010	($170)	1115
1020107:1	1115	Sell	125.47	1020107	1555	124.15	280	$1,320	1.05%	$1,770	1541	($40)	1115
1020108:2	932	Sell	124.20	1020108	1235	124.72	183	($520)	-0.42%	$450	947	($550)	1230
1020108:2	1235	Buy	124.72	1020108	1404	124.46	89	($260)	-0.21%	$480	1329	($320)	1401
1020108:2	1404	Sell	124.46	1020108	1555	124.34	111	$120	0.10%	$480	1434	($210)	1503
1020109:3	936	Buy	125.00	1020109	959	124.45	23	($550)	-0.44%	$0	936	($650)	956
1020109:3	959	Sell	124.45	1020109	1052	125.26	53	($810)	-0.65%	$300	1010	($810)	1052
1020109:3	1052	Buy	125.26	1020109	1414	125.69	202	$430	0.34%	$1,110	1336	($70)	1053
1020109:3	1414	Sell	125.69	1020109	1555	124.49	101	$1,200	0.95%	$1,220	1552	($260)	1444
1020110:4	932	Sell	123.76	1020110	1121	122.23	109	$1,530	1.24%	$2,310	1046	($240)	933
1020110:4	1121	Buy	122.23	1020110	1241	121.88	80	($350)	-0.29%	$290	1210	($350)	1241
1020110:4	1241	Sell	121.88	1020110	1555	121.84	194	$40	0.03%	$340	1540	($590)	1433
1020111:5	937	Sell	121.65	1020111	1555	120.68	378	$970	0.80%	$1,330	1347	($490)	1128
1020114:1	932	Sell	119.85	1020114	1505	118.00	333	$1,850	1.54%	$2,720	1233	($150)	932
1020114:1	1505	Buy	118.00	1020114	1553	117.86	48	($140)	-0.12%	$530	1537	($160)	1552
1020114:1	1553	Sell	117.86	1020114	1555	117.88	2	($20)	-0.02%	$10	1553	($20)	1555
1020115:2	1005	Buy	118.86	1020115	1136	118.91	91	$50	0.04%	$830	1111	($100)	1016
1020115:2	1136	Sell	118.91	1020115	1553	118.76	257	$150	0.13%	$1,150	1418	($140)	1138
1020115:2	1553	Buy	118.76	1020115	1555	118.69	2	($70)	-0.06%	$0	1553	($80)	1554
1020116:3	935	Sell	117.52	1020116	1003	117.97	28	($450)	-0.38%	$50	947	($680)	1000
1020116:3	1003	Buy	117.97	1020116	1535	117.83	332	($140)	-0.12%	$780	1507	($360)	1114
1020116:3	1535	Sell	117.83	1020116	1555	117.42	20	$410	0.35%	$450	1553	($70)	1536
1020117:4	932	Sell	119.50	1020117	934	119.45	2	$50	0.04%	$240	933	($100)	932
1020117:4	934	Buy	119.45	1020117	1000	119.36	26	($90)	-0.08%	$240	944	($90)	950
1020117:4	1000	Sell	119.36	1020117	1220	120.07	140	($710)	-0.59%	$270	1122	($730)	1219
1020117:4	1220	Buy	120.07	1020117	1445	119.98	145	($90)	-0.07%	$410	1414	($150)	1350
1020117:4	1445	Sell	119.98	1020117	1555	120.00	70	($20)	-0.02%	$750	1534	($20)	1447
1020118:5	932	Sell	114.90	1020118	953	114.49	21	$410	0.36%	$800	936	$0	932
1020118:5	953	Buy	114.49	1020118	1018	113.48	25	($1,010)	-0.88%	$0	954	($1,010)	1017
1020118:5	1018	Sell	113.48	1020118	1551	113.50	333	($20)	-0.02%	$660	1510	($640)	1052
1020118:5	1551	Buy	113.50	1020118	1555	113.80	4	$300	0.26%	$300	1555	$0	1551

FIGURE 4 Trade By Trade Summary
IBM 1min Bars FadingMemPoly System 12/26/2001 - 02/01/2002

Entry Date	Entry Time		Entry Price	Exit Date	Exit Time	Exit Price	Bars InTrd	Trade $P&L	Trade %P&L	Trade Max$Pft	Time	Trade Max$DD	Time
1020122:2	932	Buy	114.26	1020122	1020	113.60	48	($660)	-0.58%	$0	932	($820)	1016
1020122:2	1020	Sell	113.60	1020122	1555	110.42	335	$3,180	2.80%	$3,240	1543	$0	1022
1020123:3	932	Sell	110.75	1020123	1045	109.23	73	$1,520	1.37%	$2,420	1032	($320)	942
1020123:3	1045	Buy	109.23	1020123	1108	108.60	23	($630)	-0.58%	$20	1045	($650)	1107
1020123:3	1108	Sell	108.60	1020123	1314	108.25	126	$350	0.32%	$1,090	1247	($330)	1153
1020123:3	1314	Buy	108.25	1020123	1442	108.47	88	$220	0.20%	$1,000	1356	$0	1314
1020123:3	1442	Sell	108.47	1020123	1555	107.46	73	$1,010	0.93%	$1,100	1554	($40)	1448
1020124:4	932	Sell	108.76	1020124	938	108.87	6	($110)	-0.10%	$430	934	($110)	938
1020124:4	938	Buy	108.87	1020124	956	108.99	18	$120	0.11%	$680	942	$0	938
1020124:4	956	Sell	108.99	1020124	1433	107.85	277	$1,140	1.05%	$1,890	1402	($390)	1008
1020124:4	1433	Buy	107.85	1020124	1555	108.33	82	$480	0.45%	$500	1549	($190)	1452
1020125:5	932	Buy	108.11	1020125	1301	109.92	209	$1,810	1.67%	$2,480	1235	$0	932
1020125:5	1301	Sell	109.92	1020125	1540	109.84	159	$80	0.07%	$1,020	1512	($180)	1339
1020125:5	1540	Buy	109.84	1020125	1555	109.54	15	($300)	-0.27%	$110	1542	($340)	1552
Out-Of-Sample Trades Below													
1020128:1	932	Sell	109.42	1020128	1432	107.66	300	$1,760	1.61%	$2,330	1400	($690)	943
1020128:1	1432	Buy	107.66	1020128	1555	108.15	83	$490	0.46%	$590	1530	($160)	1437
1020129:2	932	Buy	108.17	1020129	951	107.47	19	($700)	-0.65%	$310	941	($860)	949
1020129:2	951	Sell	107.47	1020129	1247	104.74	176	$2,730	2.54%	$3,680	1212	($120)	953
1020129:2	1247	Buy	104.74	1020129	1326	104.15	39	($590)	-0.56%	$0	1247	($740)	1323
1020129:2	1326	Sell	104.15	1020129	1536	103.20	130	$950	0.91%	$1,650	1513	($460)	1330
1020129:2	1536	Buy	103.20	1020129	1555	103.00	19	($200)	-0.19%	$370	1546	($390)	1538
1020130:3	932	Buy	104.05	1020130	956	103.00	24	($1,050)	-1.01%	$0	932	($1,050)	939
1020130:3	956	Sell	103.00	1020130	1034	101.60	38	$1,400	1.36%	$1,800	1015	$0	956
1020130:3	1034	Buy	101.60	1020130	1127	102.46	53	$860	0.85%	$1,400	1105	$0	1034
1020130:3	1127	Sell	102.46	1020130	1219	102.99	52	($530)	-0.52%	$470	1205	($540)	1217
1020130:3	1219	Buy	102.99	1020130	1240	102.95	21	($40)	-0.04%	$760	1228	($80)	1239
1020130:3	1240	Sell	102.95	1020130	1328	103.44	48	($490)	-0.48%	$250	1315	($700)	1248
1020130:3	1328	Buy	103.44	1020130	1443	103.20	75	($240)	-0.23%	$750	1427	($240)	1443
1020130:3	1443	Sell	103.20	1020130	1508	103.84	25	($640)	-0.62%	$90	1454	($810)	1504
1020130:3	1508	Buy	103.84	1020130	1555	105.22	47	$1,380	1.33%	$1,870	1543	$0	1508
1020131:4	932	Buy	106.28	1020131	1018	106.11	46	($170)	-0.16%	$480	1001	($410)	953
1020131:4	1018	Sell	106.11	1020131	1107	105.80	49	$310	0.29%	$1,510	1053	($110)	1018
1020131:4	1107	Buy	105.80	1020131	1442	106.59	215	$790	0.75%	$1,590	1325	($180)	1110
1020131:4	1442	Sell	106.59	1020131	1537	107.11	55	($520)	-0.49%	$260	1454	($540)	1536
1020131:4	1537	Buy	107.11	1020131	1555	107.84	18	$730	0.68%	$780	1548	$0	1537
1020201:5	932	Buy	107.51	1020201	941	107.21	9	($300)	-0.28%	$290	934	($310)	938
1020201:5	941	Sell	107.21	1020201	1000	108.16	19	($950)	-0.89%	$20	941	($970)	957
1020201:5	1000	Buy	108.16	1020201	1038	108.50	38	$340	0.31%	$1,040	1023	($230)	1006
1020201:5	1038	Sell	108.50	1020201	1145	108.09	67	$410	0.38%	$940	1119	$0	1038
1020201:5	1145	Buy	108.09	1020201	1203	107.57	18	($520)	-0.48%	$0	1145	($540)	1201
1020201:5	1203	Sell	107.57	1020201	1308	107.40	65	$170	0.16%	$930	1245	($30)	1203
1020201:5	1308	Buy	107.40	1020201	1347	107.59	39	$190	0.18%	$680	1336	($80)	1308
1020201:5	1347	Sell	107.59	1020201	1555	107.12	128	$470	0.44%	$720	1505	($120)	1434

FIGURE 5 IBM 1min Bars FadingMemPoly System Chart
Out-Of-Sample 1/28/2001 to 02/01/2002

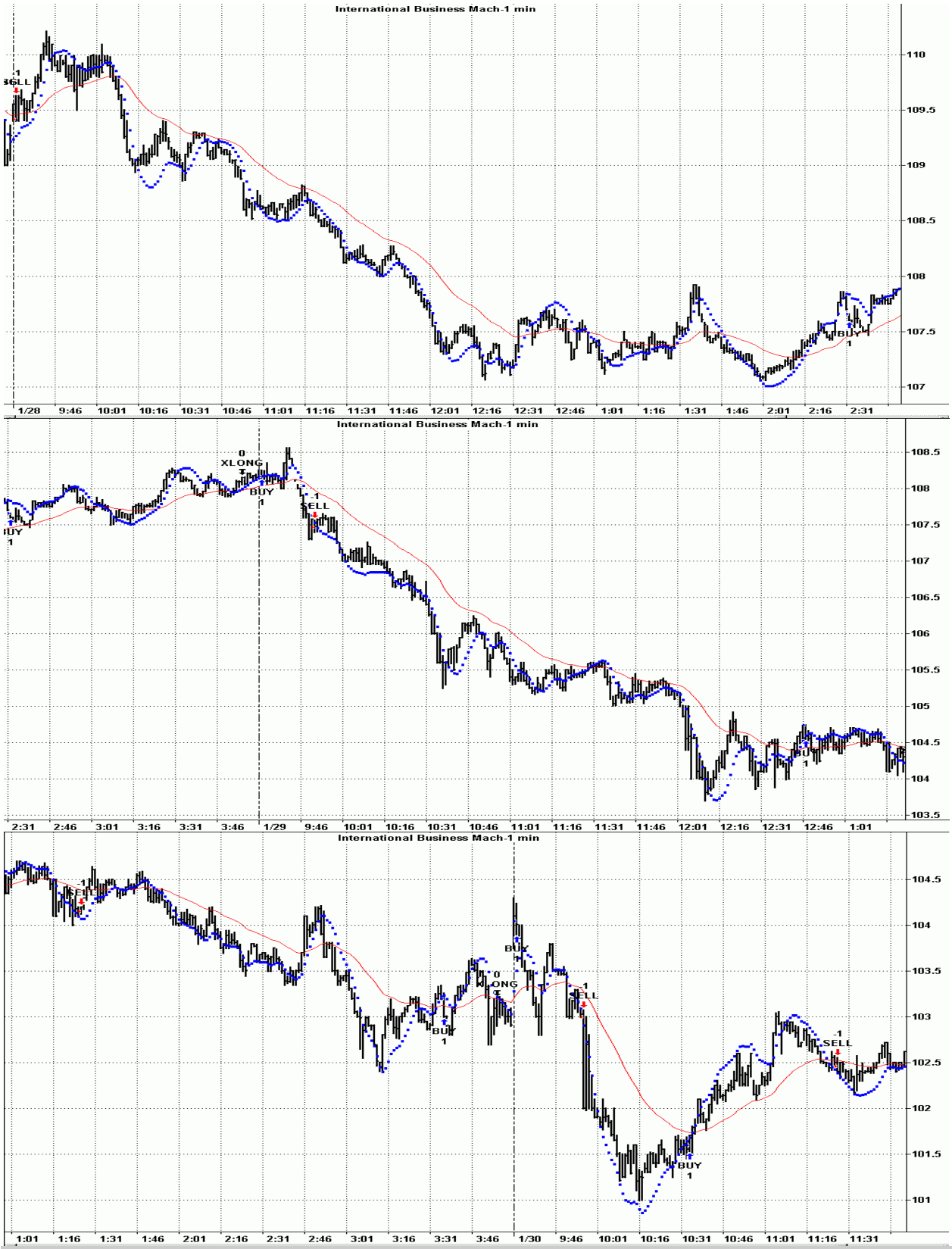

FIGURE 5 IBM 1min Bars FadingMemPoly System Chart
Out-Of-Sample 1/28/2001 to 02/01/2002