

# The Polychromatic Momentum System

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## The Polychromatic Momentum System

Momentum is defined as the difference, or percent change, between the current bar and a bar some lookback period in the past.. The major problem with using momentum based indicators is that the optimum lookback period seems to change over time creating losses with the current chosen lookback period. To avoid the errors due to a single lookback period we will create an indicator that takes an weighted average of all significant lookback periods for the tradable and call it **pcmtm**. We named this indicator polychromatic because poly means many and chromatic means colors. Thus polychromatic momentum for this indicator translates into the sum of many momentums.

Momentum (mtm), and the Polychromatic Momentum(**pcmtm**) are defined as follows.

$$\text{mtm}[i] = \text{price} - \text{price}[i]$$

The momentum magnitudes from different lookback periods are not equalized. That is, the momentum from 17 bars ago will have a range of magnitudes that are much greater than the range of momentum magnitudes of the one bar momentum. For Brownian motion random processes the expected distance a particle can move is proportional to the square root of time. Thus to equalize the effect of differences in magnitude so that the longer bar momentum magnitudes don't swamp the magnitudes of the shorter bar momentums in an average, we will weight the all momentum values. The weighting function that we chose here is  $n^\alpha$ . That is we will divide each n-bar momentum by  $n^\alpha$ . After experimenting a little it became clear that the best value of  $\alpha$  was 0.5. Thus the weighting function that we will use throughout will be  $n^{0.5}$  or the square root of n.

$$\text{pcmtm} = \sum \text{mtm}[i]/\sqrt{i} \quad \text{for } i=1 \text{ to } N$$

where the  $[i]$  bracket means the value of the bar  $i$  bars back.

In general what we will be doing is following the curve of **pcmtm**. When the **pcmtm** curve moves above the level **bxo** we will go long. When the **pcmtm** curve falls below the level **sxo** we will go short.

## The Polychromatic Momentum System Buy & Sell Rules

### Buy Rule:

If **pcmtm** has moved above the level **bxo** then buy at the market.

### Sell Rule:

If **pcmtm** has moved below the level **sxo** then sell at the market.

### Intraday Bars Exit Rule:

Close the position 5 minutes before the QQQ close (no trades will be carried overnight).

### **Intraday Bars First Trade of Day Entry Rule:**

Do not enter any trade until 9:50 EST. (explanation below)

### **Testing The Polychromatic Momentum System Using Walk Forward Optimization**

There are three system parameters to determine:

1. N, is the number to sum of the momentum values from different N lookback periods.
2. bxo, the level that pcmtm has to be above to generate a buy signal.
3. sxo, the level that pcmtm has to be below to generate a short signal.

To test this system we will use 5 minute bar prices of the Nasdaq-100 Index Tracking security traded on the AMEX and known by the symbol QQQ. We will use 5 min QQQ bars from 4/03/2002 to 5/3/2001 in the optimization test section to find the system parameters. We will then use 5 minute QQQ bars from 5/6/2002 to 5/10/2002 to test the parameters found in the previous segment on data it has not been optimized on, namely out-of-sample data. In the System Buy and Sell rules above we have included a first trade of the day entry rule. We've included this rule because often there are gaps in the open creating immediate system buys and sells. Many times these gaps are closed creating a losing whipsaw trade. In order to avoid the opening gap whipsaw trade problem we've delayed the first trade of the day until 9:50 EST.

### **Polychromatic Momentum results**

The best parameters will be defined as those values that give the best Net Profits and best Total winning Bars to Total Losing Bars ratio with the minimum drawdown and 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. Also in choosing the "best" parameters, we considered only those parameters sets whose maximum consecutive losses were 4 or less. The maximum consecutive losses are constrained to 4 or less because in real time trading it is tough to follow a system that has more than 4 losses in a row. Optimization is defined as the search for the parameter values that give the best results as defined above. It should be noted that in this stage of system development, the only thing indicated by the optimum values that are found in the test portion is that the data has been *curve fitted* as best it can with this system. Without further testing on out-of-sample data there is no way to tell if the system will work in the future.

Figure 1 presents a table of the test window selected optimum parameters for the QQQ 5min bar data series.

Start Date	End Date	N	bxo	sxo
4/3/02	5/3/02	8	0.20	-0.04

**Figure 1 Optimum Parameter Values For Test Data Segments**

Figure 2 presents the performance summary of the test window segment from 4/3/02 to 5/3/02 using the optimum parameters for the test windows shown in Figure 1.

Figure 3 presents the performance summary of the out-of-sample data segment from 5/6/02 to 5/10/02. This performance represents what would have happened in *real time* if one used the parameters found in the test sections. Slippage, and commissions are not included.

Figure 4 presents a specialized percentage trade by trade summary from 4/3/02 to 5/10/02. Note that the trades from 5/6/02 to 5/10/02 are the out-of-sample trades generated from the optimized parameters from the test sections of 4/3/02 to 5/3/02.

Figure 5 presents a 5 minute bar chart of the out-of-sample portion of QQQ with the **Polychromatic** indicator superimposed and all the buy and sell signals from the trade by trade summary of Figure 4 indicated on the charts. Also included at the bottom of the charts are the bar by bar profit or loss of each trade. This lower plot tracks the runup and drawdown of each trade.

### **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 much better than the test sample performance. The out-of-sample section average win/loss ratio, drawdowns, and profits factor were all much better than the test in-sample sections. While this better performance in the out-of-sample section was probably due to a more trending market, this performance does indicate that 4 weeks of 5 minute bar test data was enough to capture the intraday price dynamics of QQQ.

Observing the out-of-sample performance summary of Figure 3, we can see that the system did better on short trades than long trades. This better long performance was due to a longer downtrend in QQQ during this time period. The average trade (win & loss) on 1000 shares of QQQ was \$312 in the test section and \$627 in the out-of-sample section indicating stability in the parameter selection. An additional attribute of the polychromatic momentum system was that it was able to remain short all day during the down days of 5/9/02 and 5/10/02. There were no really big winners or big losers indicating steady returns.

In observing the chart we can see that the system did very well in catching every major intraday trend of QQQ. Overall the **Polychromatic Momentum** system did a good job in minimizing the losses due to the inevitable whipsaws that will occur in any trading system and maximizing the profits from the major intraday trend moves of QQQ.

In order to use this system in real time trading, at least ten to twenty more test and out-of-sample windows would have to be examined to make sure that the above results above were not due to pure chance.

### **Info on Dennis Meyers**

Dennis Meyers ([info@MeyersAnalytics.com](mailto:info@MeyersAnalytics.com)) has a doctorate in applied mathematics in engineering. He is a private trader, and president of Meyers Analytics ([www.MeyersAnalytics.com](http://www.MeyersAnalytics.com)). His firm specializes in Financial Engineering consulting for financial institutions and developing publicly available analytical software for traders.

**Figure 2 Test-Sample Performance Summary for QQQ Polychromatic System**  
**qqq-5 min bars 4/3/2002 - 5/3/2002**

**Performance Summary: All Trades**

Total Net Profit	\$6,040.00	Open position P/L	\$0.00
Gross Profit	\$10,300.00	Gross Loss	(\$4,260.00)
Total # of trades	51	Percent profitable	64.71%
Number winning trades	33	Number losing trades	18
Largest winning trade	\$1,410.00	Largest losing trade	(\$500.00)
Average winning trade	\$312.12	Average losing trade	(\$236.67)
Ratio avg win/avg los	1.32	Avg trade (win & los	\$118.43
Max consec. Winners	4	Max consec. losers	3
Avg # bars in winners	39	Avg # bars in losers	20
Max intraday drawdown(\$1,070.00)			
Profit Factor	2.42	Max # contracts held	1

**Performance Summary: Long Trades**

Total Net Profit	\$900.00	Open position P/L	\$0.00
Gross Profit	\$1,990.00	Gross Loss	(\$1,090.00)
Total # of trades	19	Percent profitable	63.16%
Number winning trades	12	Number losing trades	7
Largest winning trade	\$480.00	Largest losing trade	(\$360.00)
Average winning trade	\$165.83	Average losing trade	(\$155.71)
Ratio avg win/avg los	1.06	Avg trade (win & los	\$47.37
Max consec. Winners	3	Max consec. losers	2
Avg # bars in winners	11	Avg # bars in losers	5
Max intraday drawdown (\$530.00)			
Profit Factor	1.83	Max # contracts held	1

**Performance Summary: Short Trades**

Total Net Profit	\$5,140.00	Open position P/L	\$0.00
Gross Profit	\$8,310.00	Gross Loss	(\$3,170.00)
Total # of trades	32	Percent profitable	65.63%
Number winning trades	21	Number losing trades	11
Largest winning trade	\$1,410.00	Largest losing trade	(\$500.00)
Average winning trade	\$395.71	Average losing trade	(\$288.18)
Ratio avg win/avg los	1.37	Avg trade (win & los	\$160.63
Max consec. Winners	6	Max consec. losers	3
Avg # bars in winners	55	Avg # bars in losers	29
Max intraday drawdown(\$1,110.00)			
Profit Factor	2.62	Max # contracts held	1

**Figure 3 Out-Of-Sample Performance Summary for QQQ Polychromatic Momentum System**  
**qqq-5 min bars 5/6/2002 - 5/10/2002**

**Performance Summary: All Trades**

Total Net Profit	\$3,750.00	Open position P/L	\$0.00
Gross Profit	\$4,390.00	Gross Loss	(\$640.00)
Total # of trades	10	Percent profitable	70.00%
Number winning trades	7	Number losing trades	3
Largest winning trade	\$1,260.00	Largest losing trade	(\$300.00)
Average winning trade	\$627.14	Average losing trade	(\$213.33)
Ratio avg win/avg los	2.94	Avg trade (win & los	\$375.00
Max consec. Winners	3	Max consec. losers	1
Avg # bars in winners	46	Avg # bars in losers	17
Max intraday drawdown (\$720.00)			
Profit Factor	6.86	Max # contracts held	1

**Performance Summary: Long Trades**

Total Net Profit	\$1,070.00	Open position P/L	\$0.00
Gross Profit	\$1,370.00	Gross Loss	(\$300.00)
Total # of trades	4	Percent profitable	75.00%
Number winning trades	3	Number losing trades	1
Largest winning trade	\$1,050.00	Largest losing trade	(\$300.00)
Average winning trade	\$456.67	Average losing trade	(\$300.00)
Ratio avg win/avg los	1.52	Avg trade (win & los	\$267.50
Max consec. Winners	3	Max consec. losers	1
Avg # bars in winners	23	Avg # bars in losers	4
Max intraday drawdown (\$360.00)			
Profit Factor	4.57	Max # contracts held	1

**Performance Summary: Short Trades**

Total Net Profit	\$2,680.00	Open position P/L	\$0.00
Gross Profit	\$3,020.00	Gross Loss	(\$340.00)
Total # of trades	6	Percent profitable	66.67%
Number winning trades	4	Number losing trades	2
Largest winning trade	\$1,260.00	Largest losing trade	(\$300.00)
Average winning trade	\$755.00	Average losing trade	(\$170.00)
Ratio avg win/avg los	4.44	Avg trade (win & los	\$446.67
Max consec. Winners	2	Max consec. losers	1
Avg # bars in winners	64	Avg # bars in losers	24
Max intraday drawdown (\$520.00)			
Profit Factor	8.88	Max # contracts held	1

**FIGURE 4 Specialized Trade By Trade Summary**  
**QQQ5min Polychromatic Momentum System Trade Size = 1000 Shares 4/3/2002 to 5/10/2002**

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
4/3/02	1400	Sell	34.77	4/3/02	1610	34.78	26	(\$10)	-0.03%	\$410	1525	(\$130)	1605
4/4/02	1025	Buy	34.95	4/4/02	1100	34.91	7	(\$40)	-0.11%	\$180	1045	(\$40)	1035
4/4/02	1100	Sell	34.91	4/4/02	1550	34.72	58	\$190	0.54%	\$630	1510	\$0	1100
4/4/02	1550	Buy	34.72	4/4/02	1610	34.79	4	\$70	0.20%	\$70	1555	\$0	1550
4/5/02	1005	Sell	34.78	4/5/02	1610	34.35	73	\$430	1.24%	\$550	1525	(\$60)	1005
4/8/02	955	Sell	33.6	4/8/02	1310	34.07	39	(\$470)	-1.40%	\$130	1020	(\$470)	1305
4/8/02	1310	Buy	34.07	4/8/02	1505	34.53	23	\$460	1.35%	\$630	1425	(\$10)	1310
4/8/02	1505	Sell	34.53	4/8/02	1605	34.68	12	(\$150)	-0.43%	\$140	1505	(\$160)	1600
4/8/02	1605	Buy	34.68	4/8/02	1610	34.79	1	\$110	0.32%	\$110	1610	\$0	1605
4/9/02	1000	Sell	34.72	4/9/02	1610	33.65	74	\$1,070	3.08%	\$1,220	1600	\$0	1000
4/10/02	955	Sell	33.63	4/10/02	1040	34.13	9	(\$500)	-1.49%	\$0	955	(\$500)	1035
4/10/02	1040	Buy	34.13	4/10/02	1110	34.01	6	(\$120)	-0.35%	\$60	1040	(\$120)	1110
4/10/02	1110	Sell	34.01	4/10/02	1350	33.71	32	\$300	0.88%	\$810	1250	(\$70)	1110
4/10/02	1350	Buy	33.71	4/10/02	1450	33.89	12	\$180	0.53%	\$350	1435	\$0	1350
4/10/02	1450	Sell	33.89	4/10/02	1610	33.8	16	\$90	0.27%	\$210	1530	(\$100)	1505
4/11/02	1005	Sell	33.6	4/11/02	1610	33.07	73	\$530	1.58%	\$700	1525	(\$200)	1005
4/12/02	1010	Buy	33.41	4/12/02	1040	33.34	6	(\$70)	-0.21%	\$80	1025	(\$70)	1035
4/12/02	1040	Sell	33.34	4/12/02	1425	33.62	45	(\$280)	-0.84%	\$300	1145	(\$280)	1420
4/12/02	1425	Buy	33.62	4/12/02	1500	33.62	7	\$0	0.00%	\$80	1440	(\$20)	1455
4/12/02	1500	Sell	33.62	4/12/02	1610	33.55	14	\$70	0.21%	\$190	1525	(\$60)	1505
4/15/02	955	Sell	33.63	4/15/02	1610	33.79	75	(\$160)	-0.48%	\$320	1145	(\$250)	1440
4/16/02	955	Buy	34.66	4/16/02	1205	34.93	26	\$270	0.78%	\$350	1115	\$0	955
4/16/02	1205	Sell	34.93	4/16/02	1610	35.17	49	(\$240)	-0.69%	\$30	1305	(\$260)	1520
4/17/02	955	Sell	35.04	4/17/02	1040	35.42	9	(\$380)	-1.08%	\$20	955	(\$380)	1035
4/17/02	1040	Buy	35.42	4/17/02	1110	35.26	6	(\$160)	-0.45%	\$10	1045	(\$170)	1105
4/17/02	1110	Sell	35.26	4/17/02	1610	35.02	60	\$240	0.68%	\$550	1430	(\$30)	1120
4/18/02	1010	Sell	34.9	4/18/02	1610	34.73	72	\$170	0.49%	\$760	1220	\$0	1010
4/19/02	1005	Sell	34.77	4/19/02	1610	34.44	73	\$330	0.95%	\$360	1355	(\$60)	1005
4/22/02	955	Sell	33.82	4/22/02	1610	33.57	75	\$250	0.74%	\$530	1520	(\$20)	955
4/23/02	1000	Buy	33.71	4/23/02	1020	33.57	4	(\$140)	-0.42%	\$30	1000	(\$170)	1015
4/23/02	1020	Sell	33.57	4/23/02	1610	33	70	\$570	1.70%	\$810	1550	(\$50)	1055
4/24/02	1005	Sell	33.05	4/24/02	1610	32.43	73	\$620	1.88%	\$680	1545	(\$220)	1240
4/25/02	955	Sell	32.18	4/25/02	1310	32.49	39	(\$310)	-0.96%	\$60	1005	(\$470)	1035
4/25/02	1310	Buy	32.49	4/25/02	1405	32.5	11	\$10	0.03%	\$140	1345	(\$30)	1325
4/25/02	1405	Sell	32.5	4/25/02	1545	32.49	20	\$10	0.03%	\$430	1520	(\$70)	1410
4/25/02	1545	Buy	32.49	4/25/02	1610	32.49	5	\$0	0.00%	\$80	1550	(\$80)	1600
4/26/02	1000	Sell	32.51	4/26/02	1610	31.1	74	\$1,410	4.34%	\$1,410	1610	\$0	1000
4/29/02	1000	Buy	31.44	4/29/02	1025	31.24	5	(\$200)	-0.64%	\$20	1000	(\$220)	1020
4/29/02	1025	Sell	31.24	4/29/02	1610	31.08	69	\$160	0.51%	\$610	1500	(\$160)	1105
4/30/02	1005	Sell	31.01	4/30/02	1015	31.51	2	(\$500)	-1.61%	\$0	1005	(\$510)	1010
4/30/02	1015	Buy	31.51	4/30/02	1220	31.99	25	\$480	1.52%	\$620	1205	\$0	1015
4/30/02	1220	Sell	31.99	4/30/02	1610	31.79	46	\$200	0.63%	\$330	1550	(\$90)	1415
5/1/02	955	Sell	31.47	5/1/02	1340	31.21	45	\$260	0.83%	\$810	1130	\$0	955
5/1/02	1340	Buy	31.21	5/1/02	1450	31.46	14	\$250	0.80%	\$440	1430	\$0	1340
5/1/02	1450	Sell	31.46	5/1/02	1610	31.51	16	(\$50)	-0.16%	\$30	1455	(\$310)	1530
5/2/02	955	Buy	31.88	5/2/02	1015	31.52	4	(\$360)	-1.13%	\$0	955	(\$360)	1015
5/2/02	1015	Sell	31.52	5/2/02	1610	30.51	71	\$1,010	3.20%	\$1,030	1605	(\$120)	1015
5/3/02	955	Sell	30.01	5/3/02	1430	29.9	55	\$110	0.37%	\$500	1230	(\$30)	955
5/3/02	1430	Buy	29.9	5/3/02	1500	29.94	6	\$40	0.13%	\$250	1435	\$0	1430
5/3/02	1500	Sell	29.94	5/3/02	1610	29.65	14	\$290	0.97%	\$290	1600	(\$10)	1500

**FIGURE 4 Specialized Trade By Trade Summary**  
**QQQ5min Polychromatic Momentum System Trade Size = 1000 Shares 4/3/2002 to 5/10/2002**

**OUT -OF-SAMPLE TRADES BELOW**

Entry Date	Entry Time		Entry Price	Exit Date	Exit Time	Exit Price	Bars InTrd	Trade \$P&L	Trade %P&L	Trade Max\$Pft		Trade Max\$DD	
5/6/02	955	Buy	29.86	5/6/02	1015	29.56	4	(\$300)	-1.00%	\$50	955	(\$310)	1010
5/6/02	1015	Sell	29.56	5/6/02	1610	28.96	71	\$600	2.03%	\$660	1550	(\$380)	1315
5/7/02	955	Sell	28.97	5/7/02	1210	29.01	27	(\$40)	-0.14%	\$470	1005	(\$50)	1205
5/7/02	1210	Buy	29.01	5/7/02	1315	29.15	13	\$140	0.48%	\$250	1305	\$0	1210
5/7/02	1315	Sell	29.15	5/7/02	1610	28.74	35	\$410	1.41%	\$480	1605	(\$120)	1415
5/8/02	955	Buy	30.25	5/8/02	1305	31.3	38	\$1,050	3.47%	\$1,220	1240	(\$20)	1000
5/8/02	1305	Sell	31.3	5/8/02	1445	31.6	20	(\$300)	-0.96%	\$70	1315	(\$300)	1440
5/8/02	1445	Buy	31.6	5/8/02	1610	31.78	17	\$180	0.57%	\$260	1600	(\$110)	1510
5/9/02	955	Sell	31.67	5/9/02	1610	30.92	75	\$750	2.37%	\$800	1215	(\$170)	1000
5/10/02	955	Sell	30.82	5/10/02	1610	29.56	75	\$1,260	4.09%	\$1,280	1545	\$0	955

**FIGURE 5 QQQ5min Polychromatic Momentum System Chart  
Out-Of-Sample 5/6/2002 to 5/10/2002**

