

THE VELOCITY SYSTEM

TABLE 1 TEST-SAMPLE PERFORMANCE SUMMARY FOR LEAST SQUARES VELOCITY SYSTEM

The initial sample test period produced the following results using the optimized parameter values.

QQQ five-minute bars Oct. 9 - Nov. 8, 2002			
Performance summary: All trades			
Total net profit	\$4,400.00	Open position P/L	\$0.00
Gross profit	\$8,150.00	Gross loss	(\$3,750.00)
Total # of trades	42	Percent profitable	59.52%
Number winning trades	25	Number losing trades	17
Largest winning trade	\$1,140.00	Largest losing trade	(\$530.00)
Average winning trade	\$326.00	Average losing trade	(\$220.59)
Ratio avg. win/avg. loss	1.48	Avg. trade (win & loss)	\$104.76
Max. consec. winners	6	Max. consec. losers	3
Avg. # bars in winners	46	Avg. # bars in losers	27
Max. intraday drawdown	(\$1,450.00)		
Profit factor	2.17	Max. # contracts held	1
Performance summary: Long trades			
Total net profit	\$4,320.00	Open position P/L	\$0.00
Gross profit	\$6,560.00	Gross loss	(\$2,240.00)
Total # of trades	28	Percent profitable	60.71%
Number winning trades	17	Number losing trades	11
Largest winning trade	\$1,140.00	Largest losing trade	(\$510.00)
Average winning trade	\$385.88	Average losing trade	(\$203.64)
Ratio avg. win/avg. loss	1.89	Avg. trade (win & loss)	\$154.29
Max. consec. winners	5	Max. consec. losers	2
Avg. # bars in winners	56	Avg. # bars in losers	37
Max. intraday drawdown	(\$780.00)		
Profit factor	2.93	Max. # contracts held	1
Performance summary: Short trades			
Total net profit	\$80.00	Open position P/L	\$0.00
Gross profit	\$1,590.00	Gross loss	(\$1,510.00)
Total # of trades	14	Percent profitable	57.14%
Number winning trades	8	Number losing trades	6
Largest winning trade	\$380.00	Largest losing trade	(\$530.00)
Average winning trade	\$198.75	Average losing trade	(\$251.67)
Ratio avg. win/avg. loss	.79	Avg. trade (win & loss)	\$5.71
Max. consec. winners	3	Max. consec. losers	3
Avg. # bars in winners	24	Avg. # bars in losers	9
Max. intraday drawdown	(\$1,170.00)		
Profit factor	1.05	Max. # contracts held	1

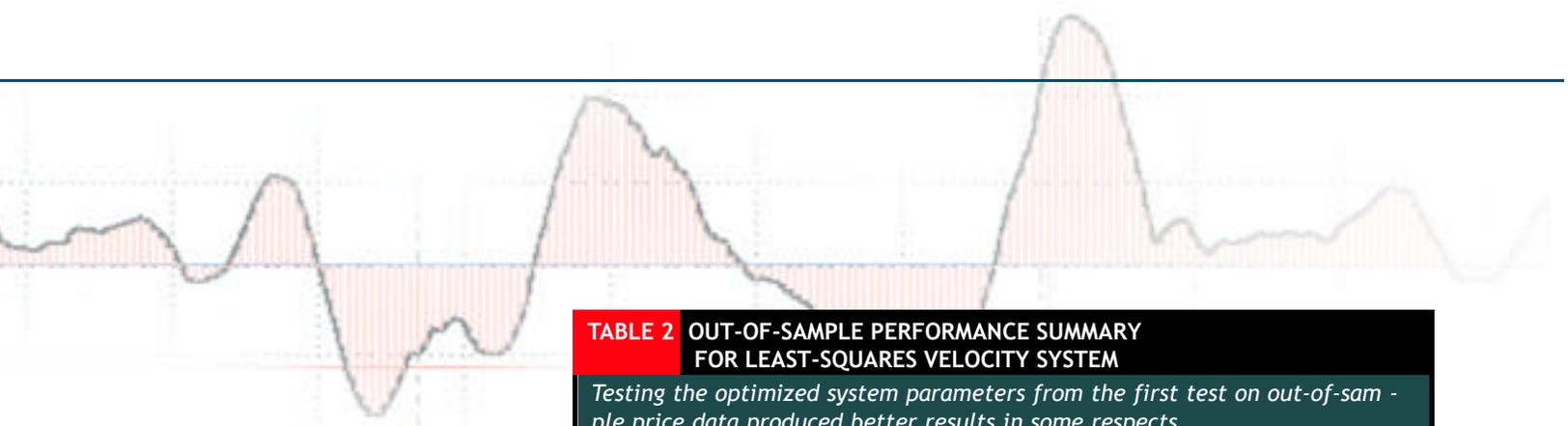
Source: TradeStation Platform by TradeStation Group

The rate of price movement in a stock can be thought of as “velocity.” Increasing positive velocity sets up long trades, while growing negative velocity sets up short trades. To filter out noise and decrease whipsaws, you can use a least-squares trendline to measure velocity and determine entry points.

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On a chart, price moves along a path relative to time. In other words, it has velocity, which is defined as the change of position per unit of time. If a stock moves sideways, the velocity is low and there are no real trading opportunities. However, if velocity begins to rise, an opportunity may occur.

There are a number of ways to measure velocity. The simplest measurement is the difference between the current price and the price x bars ago. However, there is always a large amount of “noise” (i.e., irrelevant fluctuations) in



price movement, which creates false buy and sell signals for many trading systems.

To better capture meaningful price movement, we will use another technique to measure velocity: monitoring the slope of a best-fit (or “least-squares”) trendline. The change in the slope will indicate the price velocity. The least-squares velocity acts as a price noise inhibitor or filter that identifies the underlying trend and its velocity. As a result, it’s logical to create a system that requires the velocity be greater than some threshold before buying or selling. (For more information on calculating a least-squares line, see “The least-squares line,” p. 38.)

The resulting Least-Squares Velocity (LSV) system is a cousin of the Next Bar Forecast (NBF) system described in the May 2003 issue of *Active Trader* (p. 46). Like the NBF, the LSV system will be tested on five-minute bars of the Nasdaq 100 index-tracking stock (QQQ). The results of the LSV test will be compared to those of the NBF and the Maximum Likelihood Range system (MLR), presented in “Range roving,” *Active Trader*, March 2003, p. 58.

Building a velocity system

The slope (m) of a straight line can also be called velocity. Recall that velocity is defined as the position change per time unit. Using the formula for a straight line provided in “The least-squares line,” velocity would be defined as:

$$\text{Velocity} = [b+m*(x+1)] - [b+m*x] = m$$

The least-squares velocity will be calculated at each bar. When velocity is positive and high, it indicates upward momentum and a long-trade opportunity; reverse the scenario for negative

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TABLE 2 OUT-OF-SAMPLE PERFORMANCE SUMMARY FOR LEAST-SQUARES VELOCITY SYSTEM

Testing the optimized system parameters from the first test on out-of-sample price data produced better results in some respects.

QQQ five-minute bars Nov. 11 - Nov. 22, 2002			
Performance summary: All trades			
Total net profit	\$2,760.00	Open position P/L	\$0.00
Gross profit	\$3,470.00	Gross loss	(\$710.00)
Total # of trades	17	Percent profitable	64.71%
Number winning trades	11	Number losing trades	6
Largest winning trade	\$970.00	Largest losing trade	(\$270.00)
Average winning trade	\$315.45	Average losing trade	(\$118.33)
Ratio avg. win/avg. loss	2.67	Avg. trade (win & loss)	\$162.35
Max. consec. winners	3	Max. consec. losers	2
Avg. # bars in winners	46	Avg. # bars in losers	30
Max. intraday drawdown	(\$470.00)		
Profit factor	4.89	Max. # contracts held	1
Performance summary: Long trades			
Total net profit	\$2,670.00	Open position P/L	\$0.00
Gross profit	\$3,010.00	Gross loss	(\$340.00)
Total # of trades	11	Percent profitable	72.73%
Number winning trades	8	Number losing trades	3
Largest winning trade	\$970.00	Largest losing trade	(\$150.00)
Average winning trade	\$376.25	Average losing trade	(\$113.33)
Ratio avg. win/avg. loss	3.32	Avg. trade (win & loss)	\$242.73
Max. consec. winners	4	Max. consec. losers	1
Avg. # bars in winners	56	Avg. # bars in losers	49
Max. intraday drawdown	(\$340.00)		
Profit factor	8.85	Max. # contracts held	1
Performance summary: Short trades			
Total net profit	\$90.00	Open position P/L	\$0.00
Gross profit	\$460.00	Gross loss	(\$370.00)
Total # of trades	6	Percent profitable	50.00%
Number winning trades	3	Number losing trades	3
Largest winning trade	\$280.00	Largest losing trade	(\$270.00)
Average winning trade	\$153.33	Average losing trade	(\$123.33)
Ratio avg. win/avg. loss	1.24	Avg. trade (win & loss)	\$15.00
Max. consec. winners	2	Max. consec. losers	2
Avg. # bars in winners	19	Avg. # bars in losers	12
Max. intraday drawdown	(\$380.00)		
Profit factor	1.24	Max. # contracts held	1

Source: TradeStation Platform by TradeStation Group

Least-squares line

Linear regression is a way to calculate a straight line that best fits a series of data points – that is, a line that most accurately reflects the slope, or trend, of that data. In terms of price analysis, a linear regression line is used to determine the trend of closing prices over a given time period. Because it is mathematically derived, a regression line, or “best-fit” line, is not based on subjective, visual analysis, as are standard trendlines.

Figure 1 (right) shows a group of five closing prices on a price chart. A straight line that goes through the “middle” of those five prices – a line for which the difference between it and each of the zigzagging prices is as small as possible – is a regression line.

Calculation

A regression line is calculated using the “least-squares” method, which refers to finding the minimum squared ($x \cdot x$, or x^2) differences between price points and a straight line. For example, if two closing prices are 2 and 3 points away (the distance being calculated vertically) from a straight line, the squared differences between the points and the line are 4 and 9, respectively.

Why are the squared differences used, instead of just the differences? Figure 1 shows that some differences are negative (for points below the line) and others are positive (for points above the line). This makes it necessary to square all the differences, creating all positive values and making it possible to calculate a formula for the straight line.

The best-fit line is the line for which the sum of the squared differences between each price and the straight line are minimized.

The formula for a straight line (y) is:

$$y = b + m \cdot x$$

where

x = the “time” of the price (the x -axis value)

b = the initial value of the line when “ x ” is equal to zero (the “intercept” value – i.e., the point at which the line intercepts the vertical axis);

m = the slope of the line, which is the rate at which the line rises or falls. In other words, b is how much y changes for a one-unit change in x (e.g., .75 points per day).

As prices change, the slope of the line also changes. When a market is rising sharply the slope (b) has a high value and the line will be steep. As the market slows down, the slope value decreases and the line will slope upward more gently.

When calculating a straight line to N prices, the “best-fit” coefficients b and m can be solved for by:

$$b = \left[\frac{4N+2}{N^2-N} \right] \sum_{x=1}^N p(x) + \left[\frac{6}{N^2-N} \right] \sum_{x=1}^N x \cdot p(x)$$

$$m = \left[\frac{12}{N^3-N} \right] \sum_{x=1}^N x \cdot p(x) - \left[\frac{6}{N^2-N} \right] \sum_{x=1}^N p(x)$$

where

$p(x)$ is the price at point x .

N is the number of prices used to calculate the coefficients – e.g., $N = 5$ for a five-day regression calculation. In this case, the first day $p(1)$ in the price series is 1 and the last price $p(N)$ in the series is 5.

$\sum_{x=1}^N p(x)$ is the sum of the prices for $p(1)$ through $p(N)$. For example, if $N = 5$ and the prices for days 1 and 2 are 10, 11, 12, 13 and 14, respectively, the sum is 60.

$\sum_{x=1}^N x \cdot p(x)$ is the sum of the products of time (x) and price (p). For example, the products of the prices used in the previous calculation are 10 ($1 \cdot 10$), 22 ($2 \cdot 11$), 36 ($3 \cdot 12$), 52 ($4 \cdot 13$) and 70 ($5 \cdot 14$), and the sum of those products is 190.

Figure 2 (right) shows the calculations and chart of three five-day regression lines calculated at different points over a 10-day period: Line A covers days 1 through 5; line B represents days 4 through 8; and line C is days 6 through 10. The linear regression estimates for the slopes (b) and intercept values (a) are listed in the third and fourth columns. The values for each of the five points that make up regression lines A, B and C are in the final three columns

The slope for line A (days 1-5), which accompanies an upward trend, is 0.60. Price continued to rally higher in days 6 through 8, but at a slower rate, which resulted in a slope of .43 for line B. For line C, when price moved sideways to lower, the slope was -0.07.

FIGURE 1 FITTING A STRAIGHT LINE TO PRICES

A regression or "best-fit" line is calculated to minimize the difference between price points and the line. In doing so, the line approximates the slope (trend) of the prices.

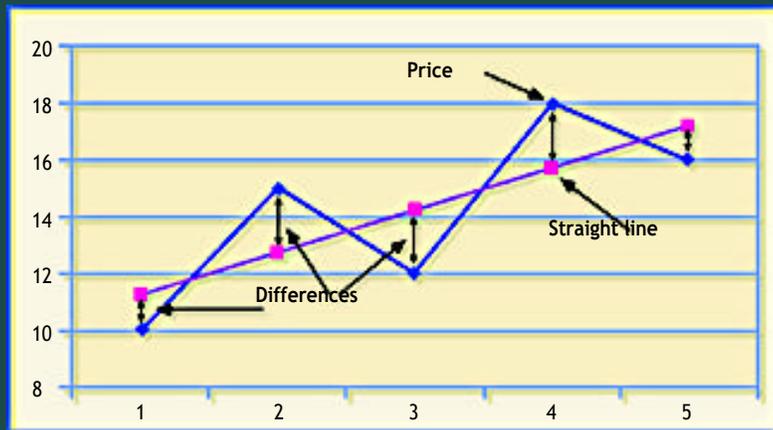
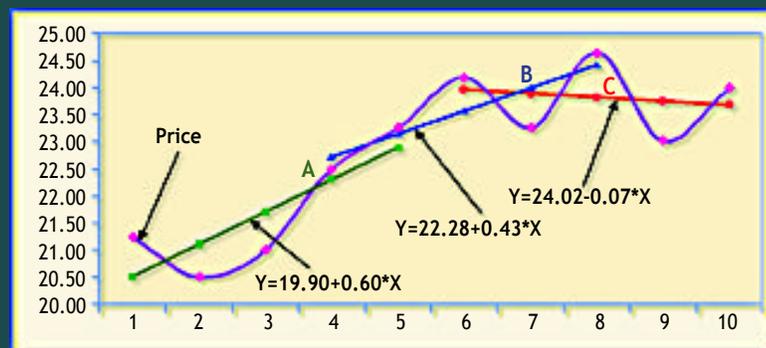


FIGURE 2 REGRESSION LINES

The following calculations resulted in the three different five-day regression lines on the chart below.

Day	Price	Slope (m)	Intercept (b)	Line A	Line B	Line C
1	21.25			20.50		
2	20.50			21.10		
3	21.00			21.70		
4	22.50			22.30	22.71	
5	23.25	0.60	19.90	22.90	23.14	
6	24.20				23.57	23.95
7	23.25				24.00	23.89
8	24.66	0.43	22.28		24.44	23.82
9	23.00					23.76
10	24.00	-0.07	24.02			23.69



velocity and short trades. One of the goals, therefore, is determining what constitutes strong upward and downward velocity.

Using this basic velocity principle, when velocity exceeds a certain threshold (to be determined later through optimization), we will go long. When velocity is less than a certain threshold, we will go short. These are the rules:

1. Buy rule: If velocity is greater than the threshold amount *vup*, buy QQQ at the market.

2. Sell rule: If velocity is less than the threshold amount *-vdn*, sell QQQ at the market.

3. Intraday bars exit rule: Close the position five minutes before the close (no trades are carried overnight).

4. Intraday bars first trade of day entry rule: Ignore all trade signals before 10 a.m. ET (30 minutes after the open). Opening gaps that create trigger trades are often closed quickly, creating losing whipsaw trades. This rule is designed to avoid the problem.

Testing the system

We will use historical testing to determine the "best" systems parameters, which are defined as the values that produce the highest average per-trade net profit and the highest total winning bars to total losing bars ratio, with the smallest drawdown, largest losing trade value and no more than four losses in a row (because of the psychological difficulty of trading a system that produces more consecutive losers than this).

In addition, these parameters should produce stable results, which means the profit, winning percentage and drawdown figures should not change by much as the parameters are adjusted a small amount either way.

A "walk-forward" optimization test was used consisting of an initial test on a "sample" data set (used to determine

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FIGURE 1 QQQ FIVE-MINUTE BARS LEAST-SQUARES VELOCITY SYSTEM

Trades from the out-of-sample test are shown along with the bar-by-bar profit or loss (below the price series). Overall, the system was effective at catching intraday trends during this period.



Source: TradeStation Platform by TradeStation Group

the optimal system values — i.e., the “best” parameters — for that period) and a second test on an “out-of-sample” data set using the optimal parameters, which will allow us to verify their value. The sample data period consisted of one month of five-minute QQQ bars (Oct. 9 to Nov. 8, 2002), and the out-of-sample data was two weeks of five-minute QQQ bars (Nov. 11 to Nov. 22, 2002).

The sample portion of such a test is likely to produce favorable results, but this does not mean the system will perform well in real trading. Only successful performance on out-of-sample data can provide any indication a system will work in the future.

There are three system parameters to determine in the optimization:

1. *Len*, the lookback period to calculate velocity;
2. *vup*, the threshold amount velocity has to be greater than to issue a buy signal; and
3. *vdn*, the threshold amount velocity has to be less than to issue a sell signal.

The optimal system parameters derived from the initial sample-test data are shown below:

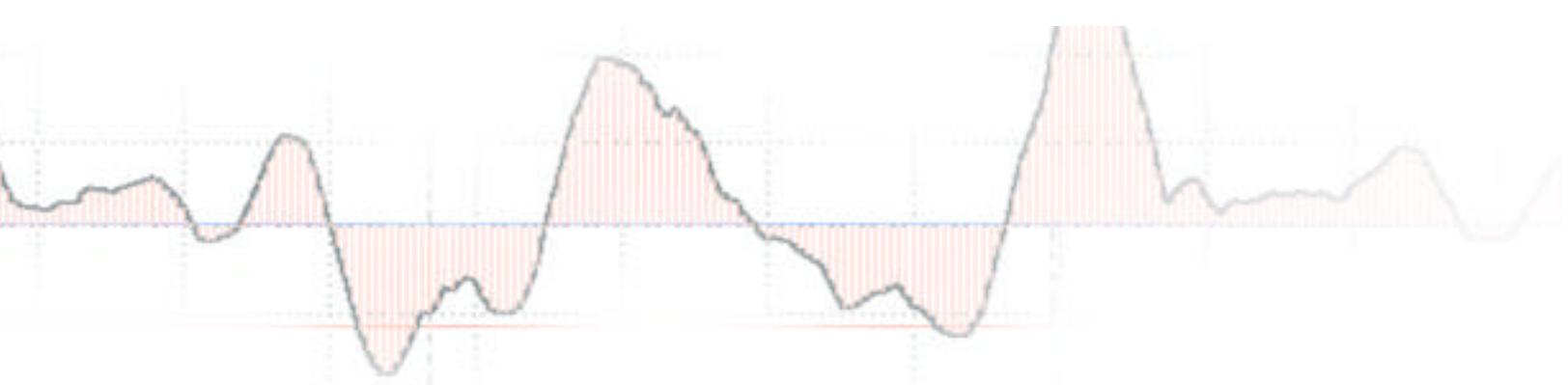
Start date	End date	Len	vup	vdn
10/9/02	11/8/02	16	0.001	0.023

Table 1 (p. 36) shows the performance summary of the sample test segment.

These parameters were then tested on the out-of-sample data to simulate the experience of trading in real-time on new price data. Table 2 (p. 37) shows the performance summary of the out-of-sample test. Slippage and commissions are not included in any of the test results.

Live vs. Memorex

As it turned out, a comparison of Tables 1 and 2 shows the out-of-sample results were better than the in-sample results. The average win/loss ratio, drawdown and profit factor were all better in the



out-of-sample data.

However, there was a more trending price action in the out-of-sample period, and much of the superior performance can likely be attributed to that. Specifically, Table 2 shows the system did much better on long trades than short trades, the result of a long uptrend in the out-of-sample period.

The average trade (on 1,000 shares of QQQ) resulted in a \$105 profit in the test section and \$162 in the out-of-sample section. The profit factor in the out-of-sample section was twice as high as the comparable figure in the test section. Also, during every up day from Nov. 11 to Nov. 22, the system remained in one long trade all day, showing the system was able to avoid getting knocked out of the market and having to re-enter, resulting in whipsaw losses. Also, the system produced no big winners or big losers, which means the system did not rely on a few exceptional trades that are not representative of the system's basic characteristics.

Figures 1a-1c (opposite page) are five-minute price charts of QQQ from Nov. 11 to Nov. 22 (the out-of-sample period). The Least-Squares Velocity indicator is plotted along with price. (The buy and sell signals can be viewed as part of the trade-by-trade summary of the out-of-sample trades in the Web Extra for this article at www.activetradermag.com from June 10 to June 30.) These charts show the system produced steady returns, which is all anyone can ask of a trading system.

System comparison

One reason for choosing these particular test periods was to compare the LSV out-of-sample results with the out-of-sample results of the Next Bar Forecast system (NBF) and the Maximum Likelihood Range system (MLR).

Tables 3 (right) and 4 (p. 45) show the performance summary of the MLR system and the NBF system, respectively, on the out-of-sample data segment from Nov. 11 to Nov. 22, 2002.

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TABLE 3 OUT-OF-SAMPLE PERFORMANCE SUMMARY FOR MAXIMUM LIKELIHOOD RANGE SYSTEM

The net profit of the LSV system was similar to that of the Maximum Likelihood Range system. However, the drawdown and largest losing trade were much less for the LSV.

QQQ five-minute bars Nov. 11 - Nov. 22, 2002			
Performance summary: All trades			
Total net profit	\$2,680.00	Open position P/L	\$0.00
Gross profit	\$3,570.00	Gross loss	(\$890.00)
Total # of trades	11	Percent profitable	63.64%
Number winning trades	7	Number losing trades	4
Largest winning trade	\$1,110.00	Largest losing trade	(\$490.00)
Average winning trade	\$510.00	Average losing trade	(\$225.50)
Ratio avg. win/avg. loss	2.29	Avg. trade (win & loss)	\$246.64
Max. consec. winners	4	Max. consec. losers	3
Avg. # bars in winners	71	Avg. # bars in losers	52
Max. intraday drawdown	(\$910.00)		
Profit factor	4.01	Max. # contracts held	1
Performance summary: Long trades			
Total net profit	\$2,760.00	Open position P/L	\$0.00
Gross profit	\$3,570.00	Gross loss	(\$810.00)
Total # of trades	10	Percent profitable	70.00%
Number winning trades	7	Number losing trades	3
Largest winning trade	\$1,110.00	Largest losing trade	(\$490.00)
Average winning trade	\$510.00	Average losing trade	(\$270.00)
Ratio avg. win/avg. loss	0.89	Avg. trade (win & loss)	\$276.00
Max. consec. winners	4	Max. consec. losers	2
Avg. # bars in winners	71	Avg. # bars in losers	66
Max. intraday drawdown	(\$830.00)		
Profit factor	4.41	Max. # contracts held	1
Performance summary: Short trades			
Total net profit	(\$80.00)	Open position P/L	\$0.00
Gross profit	\$0.00	Gross loss	(\$80.00)
Total # of trades	1	Percent profitable	0.00%
Number winning trades	0	Number losing trades	1
Largest winning trade	\$0.00	Largest losing trade	(\$80.00)
Average winning trade	\$0.00	Average losing trade	(\$80.00)
Ratio avg. win/avg. loss	(0.00)	Avg. trade (win & loss)	(\$80.00)
Max. consec. winners	0	Max. consec. losers	1
Avg. # bars in winners	0	Avg. # bars in losers	8
Max. intraday drawdown	(\$220.00)		
Profit factor	(0.00)	Max. # contracts held	1

Source: TradeStation Platform by TradeStation Group

Advanced Strategies

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The LSV system produced an out-of-sample net profit of \$2,760, while the MLR produced a net profit of \$2,680. However, the LSV's slightly higher net profits were produced with about 50 percent more trades. The LSV system had a per-trade net profit of \$162 compared to the MLR system's \$243.

If \$50 for slippage and commission were subtracted from each system for each trade, the total net profits of each system would still be approximately the same. However, in looking at the out-of-sample drawdowns and largest losing trades, the LSV system has a clear advantage. In both cases, the MLR figures are almost twice those of the LSV.

In comparison with the NBF system, the LSV system produced a net profit of \$470 less than the NBF (\$2,760 vs. \$3,230). The NBF's higher profits were produced with more trades. The LSV system had an average profit-per-trade of \$162; the average profit-per-trade for the MLR system was \$134. Again, subtracting \$50 for slippage and commission per trade would make these figures much closer.

Looking at the out-of-sample drawdowns and largest losing trades of each system, the NBF has a clear advantage. Its results in those categories are half of what the LSV system produced. In addition, the NBF system was able to generate short trade profits while LSV system was only minimally effective in this regard and the MLR lost money on the short side.

Overall, the NBF system performed much better on the out-of-sample data than the Maximum Likelihood Range system or the Least-Square Velocity system.

At least 20 more tests on different sets of sample and out-of-sample data would be necessary to confirm the viability of the results shown here. Both test periods were dominated by uptrending conditions; down markets have different intraday characteristics that could significantly affect system performance. 

For information on the author see p. 10.

TABLE 4 OUT-OF-SAMPLE PERFORMANCE SUMMARY FOR NEXT BAR FORECAST SYSTEM

Overall, the Next Bar Forecast system did a better job of trading the QQQs than the LSV system.

QQQ five-minute bars Nov. 11 - Nov. 22, 2002			
Performance summary: All trades			
Total net profit	\$3,230.00	Open position P/L	\$0.00
Gross profit	\$4,160.00	Gross loss	(\$930.00)
Total # of trades	24	Percent profitable	58.33%
Number winning trades	14	Number losing trades	10
Largest winning trade	\$970.00	Largest losing trade	(\$190.00)
Average winning trade	\$297.14	Average losing trade	(\$93.00)
Ratio avg. win/avg. loss	3.20	Avg. trade (win & loss)	\$134.58
Max. consec. winners	7	Max. consec. losers	3
Avg. # bars in winners	39	Avg. # bars in losers	17
Max. intraday drawdown	(\$420.00)		
Profit factor	4.47	Max. # contracts held	1
Performance summary: Long trades			
Total net profit	\$2,860.00	Open position P/L	\$0.00
Gross profit	\$3,400.00	Gross loss	(\$540.00)
Total # of trades	15	Percent profitable	60.00%
Number winning trades	9	Number losing trades	6
Largest winning trade	\$970.00	Largest losing trade	(\$190.00)
Average winning trade	\$377.78	Average losing trade	(\$90.00)
Ratio avg. win/avg. loss	4.20	Avg. trade (win & loss)	\$190.64
Max. consec. winners	5	Max. consec. losers	3
Avg. # bars in winners	51	Avg. # bars in losers	24
Max. intraday drawdown	(\$380.00)		
Profit factor	6.30	Max. # contracts held	1
Performance summary: Short trades			
Total net profit	(\$370.00)	Open position P/L	\$0.00
Gross profit	\$760.00	Gross loss	(\$390.00)
Total # of trades	9	Percent profitable	55.56%
Number winning trades	5	Number losing trades	4
Largest winning trade	\$240.00	Largest losing trade	(\$140.00)
Average winning trade	\$152.00	Average losing trade	(\$97.50)
Ratio avg. win/avg. loss	1.56	Avg. trade (win & loss)	(\$41.11)
Max. consec. winners	2	Max. consec. losers	1
Avg. # bars in winners	18	Avg. # bars in losers	6
Max. intraday drawdown	(\$230.00)		
Profit factor	1.95	Max. # contracts held	1

Source: TradeStation Platform by TradeStation Group