The Breakout Bulletin

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For past issues, go to http://www.breakoutfutures.com/Newsletters/index.html.

News Items

This is the first issue of the Breakout Bulletin since February. The reason I haven't written in so many months is that I've been busy developing a new windows software program for trading system analysis and money management. I'll have more to say about my new product -- Market System Analyzer -- below, but if you want to check it out for yourself, please visit http://www.adaptrade.com/product.htm.

Even though I've been spending a lot of time on new projects, I'm still following and selling my MiniMax system for the e-mini's. If you're not familiar with MiniMax and you want to learn more about it, please visit http://www.breakoutfutures.com/MiniMax/index.html or feel free to contact me directly (see bottom of this newsletter for contact information). I also have a free pdf report on the system available at http://www.breakoutfutures.com/MiniMax/MMIIReport.html. The report includes detailed performance information, a description of the system, and examples of the types of orders generated by the system.

Better Optimization in TradeStation

Optimizing a trading system is a little like the way laws are passed in Congress. You may not like the process, but it's probably better than having no laws at all. If your trading system has one or more parameters, you have to choose values for those parameters, whether or not you like the process of selecting them. Of course, you could always pick numbers at random, throw darts at a calendar, or take the last two digits of your social security number, but optimization usually (although not always) seems like a more rationale approach. The well known drawback of optimization is that too much optimization is not a good thing. If done imprudently, optimization can curve-fit a trading system so tightly to the market data used in the optimization that the system has no chance of performing well on any other data. That kind of over-optimization has led many trading pundits to reject optimization of any kind. In past issues of this newsletter (see April and May, 2003), I've tried to show that optimization can be perfectly acceptable provided it's performed over a sufficiently large sample of trades. The more trades used in the optimization, the more likely it is that the optimized system will hold up well in the future.

Of course, there are no free lunches. When you optimize over a large samples of trades, it can be difficult to find parameter values that work consistently well over all time periods and market conditions in the sample. In particular, the optimization can sometimes get "stuck" on one set of favorable market conditions, leaving the system's performance elsewhere flat or poor. For example, when optimizing a trading system for the stock indices, the optimal results may be unduly influenced by the bubble market conditions that led up to the peak in early 2000. If you optimize for net profit, for example, you could end up with a system that looks great in terms of net profit, profit factor, average trade, drawdown, and most other summary statistics. But when you look at the equity curve, you'd see that most of the profit was made from 1999 to early 2000 and that the system was flat or down most other years. Another common problem is when you can't find optimal results that give good recent performance, even though the performance everywhere else in the past is good. Personally, I like to use parameter values that have been doing well in recent trading. I'd rather use parameter values that have been only OK in recent years but great in recent trading than values that were great in past years but poor in recent trading.

As an example, consider the following equity curve for the Japanese Yen. This was produced by optimizing a simple channel breakout system in TradeStation. The system has a single parameter, the length of the channel. Based on optimizing for net profit, the optimal channel length is 34 bars. Most of the equity curve looks great -- a nearly straight line up to the peak. However, the first major peak is on February 2000, followed by the second major peak on July 2002. Since then, the system has been in a drawdown. If you had been trading this system, you wouldn't have made any money since early 1998 and would be down substantially since mid-2002. That's a long time to trade a system that isn't doing well.

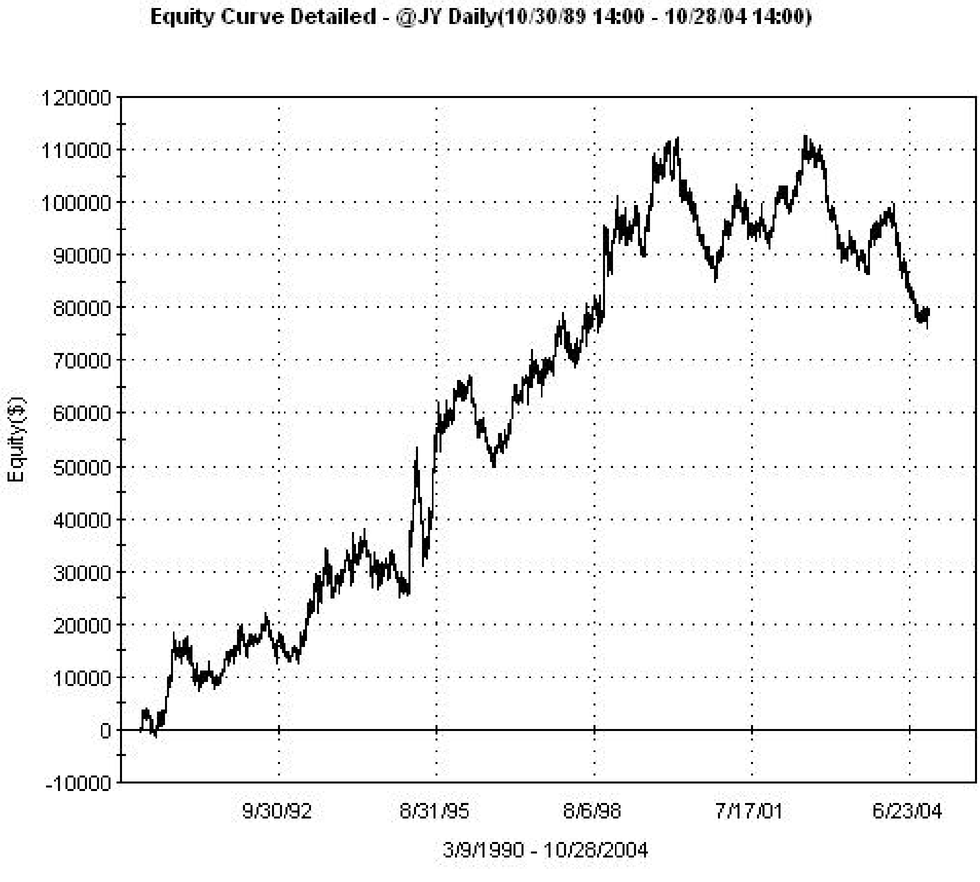

Fig. 1. Equity curve for channel breakout system with a channel length of 34 bars, obtained by optimizing for net profit.

The problem may be that this type of system is inherently subject to big swings in equity. However, the fact that it did consistently well for many years prior to 2000 calls that into question. It may be that the Yen market has fundamentally changed, and the system is no longer capable of performing well. However, it may also be that using net profit as the optimization objective is too simple. The system did so well for the first 10 years with one particular parameter value that even with the poor performance in subsequent years, the net profit is still higher than from any other parameter value. TradeStation lets you select other performance measures for the optimization, but none of the other choices gives better results in this case. The problem is that all the optimization objective choices in TradeStation are simple summary statistics.

In order to tell for sure whether the problem is with the system or with the optimization, we need a better optimization objective. Since we can't simply add an optimization objective to TradeStation, I came up with the following procedure to work around the problem:

1. Implement an optimization objective as an EasyLanguage function so that each time the system is run, the objective function is computed. Have the function append the system input values and the objective function value to a file, so that each time the system is run, a line is added to the file.
2. Use TradeStation's built-in optimization feature to iterate over different combinations of the system's input parameters. For each set of parameter values, the function will add the parameter values and objective function value to the file. There'll be one line in the file for each set of parameter values.
3. Import the text file into a spreadsheet and sort the rows according to the value of the objective function. The row at the top will contain the optimal values of the input parameters.

I'll illustrate this procedure in a moment, but first we need an optimization objective. The problem with the Yen system was that the optimization neglected the performance in recent years. The result was that the equity curve tailed off at the end. One way to address this is to look for parameter values that give a straight-line equity curve. We would take the parameter values that produced the straightest, upward sloping equity curve. We can quantify how straight a curve is using the **correlation coefficient**. The correlation coefficient measures the linearity ("straightness") of the relationship between the x and y data of an x-y plot. The correlation coefficient is given by the following equation:

$$R = [N * \mathrm{Sum}(Xi * Yi) - \mathrm{Sum}(Xi) * \mathrm{Sum}(Yi)]/\mathrm{sqrt}[[N * \mathrm{Sum}(Xi * Xi) - \mathrm{Sum}(Xi)*\mathrm{Sum}(Xi)] * [N * \mathrm{Sum}(Yi * Yi) - \mathrm{Sum}(Yi)*\mathrm{Sum}(Yi)]]$$

where N is the number of data points, (Xi, Yi) is the ith data point, Sum() represents the summation of values from i = 1 to i = N, and sqrt() is the square root. The correlation coefficient, R, lies between -1 and +1. A R value of +1 means the relationship between x and y is perfectly linear with a positive slope, which is what we want to see in our equity curve. A value of zero means there is no correlation, and a value of -1 means the x and y values are negatively correlated. To measure the correlation coefficient for an equity curve, we can take Xi as the number of the ith bar, and Yi as the total equity value (open plus closed trade equity) on the ith bar.

Taking the correlation coefficient as our sole objective function may be too simplistic. We could end up with a straight equity curve but very low profitability. To avoid this, we can add a term to the objective function to account for net profit. Our objective function, which we'll want to maximize, will be a sum of the correlation coefficient and the net profit. To make sure both terms contribute equally to the optimization, we need to scale them so that each term is in the range [0, 1]. Consider the following objective function:

$$OF = OW1 * [(R - Rmin)/(Rmax - Rmin)] + OW2 * [(P - Pmin)/(Pmax - Pmin)]$$

where Rmin is the minimum value of the correlation coefficient over all optimization iterations, Rmax is the maximum value of R, P is the net profit, Pmin is the minimum value of P over all optimization iterations, Pmax is the maximum value of P, and OW1 and OW2 are objective function weights. We won't know Rmin, Rmax, Pmin, and Pmax until we run through the optimization once. We can then make a note of the maximum and minimum values of R and P and use those to set Rmin, Rmax, Pmin, and Pmax for the final optimization. The weights OW1 and OW2 allow us to give more emphasis to either term. For example, if we want to emphasize straightness of the equity curve over profitability, we could make OW1 larger than OW2.

Before putting this into action, there's one other feature that can help with the optimization. Recall that the problem with the Yen system was limited to the most recent part of the equity curve. Another way to address this is to weight the most recent part of the equity curve higher than the early part of the curve. Specifically, rather than using the net profit, P, in the objective function, we could use a "weighted" net profit. The weighted net profit can be computed as the weighted sum of the equity changes from bar to bar, with the value of the weight increasing from bar to bar, so that more recent bars have higher weights. To increase the weight linearly, the following equation can be used:

$$wi = (M - 1)/(N - 1) * (i - 1) + 1$$

where wi is the nonnormalized weight for the ith bar, M is a factor that determines how much higher the weight is on the last bar relative to the first bar, N is the number of bars (as above), and i is the bar number. To keep the weighted net profit in the same numeric range as the unweighted net profit, the weights, wi, should be normalized as follows:

$$Wi = wi/[Sum(wi)/N]$$

where Wi are the normalized versions of the wi. The weighted net profit can then be computed as follows:

$$PW = Sum(Wi * Eqi)$$

where Eqi is the equity change from bar i - 1 to bar i. Note that if M = 1, indicating that the weight is the same on the last bar as on the first bar, then wi = 1 for all i, and Wi = 1 for all i. The result is that the weighted net profit is equal to the net profit, PW = P. So in the trivial case of no weighting, the equation for PW reduces down to P as it should. To put more emphasis on the more recent part of the equity curve, set M to a multiple of one; e.g., M = 10.

Using the weighted net profit, the final version of our objective function can be written as follows:

$$F = OW1 * [(R - Rmin)/(Rmax - Rmin)] + OW2 * [(PW - PWmin)/(PWmax - PWmin)]$$

where the weighted net profit, PW, has been substituted for the net profit, P. In practice, since we've normalized the weights for the net profit, the minimum and maximum values of PW will be close to the minimum and maximum values of P, so Pmin and Pmax can be used in place of PWmin and PWmax if you prefer. In fact, it's only necessary to use approximate values for Rmin, Rmax, PWmin, and PWmax in any case since we can always adjust things using the weighting factors.

Here's the EasyLanguage code for a function that implements this objective function.

```
{
 Function EqtyCorr

 Calculate an objective function based on the weighted sum of
 the correlation coefficient of the equity curve and the net profit.
 Append the objective function value and system input parameter
 values to a file.
 In the following, X represents the bar number, and Y is the
 total equity (closed trade net profit plus open position profit).

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}
 input: Param1      (NumericSimple),    { system parameter 1 }
        Param2      (NumericSimple),    { system parameter 2 }
        Param3      (NumericSimple),    { system parameter 3 }
        Param4      (NumericSimple),    { system parameter 4 }
        Param5      (NumericSimple),    { system parameter 5 }
        CCMin       (NumericSimple),    { min value of coeff }
        CCMax       (NumericSimple),    { max value of coeff }
        EqMin       (NumericSimple),    { min net profit }
        EqMax       (NumericSimple),    { max net profit }
        WeightCC    (NumericSimple),    { weight for coeff }
        WeightEq    (NumericSimple),    { weight for net profit }
        FName       (StringSimple);     { file name to write results to
}

 Var:  XVal      (0),     { value of x, scaled bar number }
       YVal      (0),     { value of y, scaled equity }
       SumXY     (0),     { sum of X * Y }
       SumX      (0),     { sum of X }
       SumY      (0),     { sum of Y }
       SumXX     (0),     { sum of X * X }
       SumYY     (0),     { sum of Y * Y }
       CCNum     (0),     { numerator of correlation coefficient }
       CCDen     (0),     { denominator of correlation coefficient }
       CorrCoef  (0),     { correlation coefficient }
       ObjectFn  (0),     { correlation times net profit }
       TotalEqty (0),     { open plus closed trade equity }
       TotProf   (0),     { total profit from weighted sum }
       PWNum     (0),     { numerator of profit weights }
       PWDen     (0),     { denominator of profit weights }
       PWFact    (100),   { factor determining profit weighting }
       ii        (0),     { loop counter }
       NBars     (0),     { number of bars on chart }
       StrOut    ("");

 Array: EqtyCh[5000](0);  { handles up to 5000 bars of data }

 TotalEqty = NetProfit + OpenPositionProfit;
 If BarNumber < 5000 then
    EqtyCh[BarNumber] = TotalEqty - TotalEqty[1];

 XVal = BarNumber/100.;
 YVal = TotalEqty/10000.;
 SumX = SumX + XVal;
 SumY = SumY + YVal;
 SumXY = SumXY + (XVal * YVal);
 SumXX = SumXX + (XVal * XVal);
 SumYY = SumYY + (YVal * YVal);
 {Print("Bar: ", BarNumber:0:0, "  SumX = ", SumX:0:0, "  SumY = ",
SumY:0:2, "  SumXY = ", SumXY:0:2,
                "  SumXX = ", SumXX:0:0, "  SumYY = ", SumYY:0:2); }

 If LastBarOnchart then Begin
    NBars = BarNumber;

    { Calculate weighted net profit }
    for ii = 1 to NBars Begin
        PWDen = PWDen + (PWFact - 1)/(NBars - 1) * (ii - 1) + 1;
    End;
    PWDen = PWDen/NBars;

    for ii = 1 to NBars Begin
        PWNum = (PWFact - 1)/(NBars - 1) * (ii - 1) + 1;
        TotProf = TotProf + EqtyCh[ii] * PWNum/PWDen;
    End;

    { Calculate correlation coefficient }
    CCNum = NBars * SumXY - (SumX * SumY);
    CCDen = SquareRoot((NBars * SumXX - (SumX * SumX))  * (NBars *
SumYY - (SumY * SumY)));
    if CCDen > 0 then
       CorrCoef = CCNum/CCDen
    else
       CorrCoef = 0;

    { Objective function is weighted sum of profit plus correlation }
    ObjectFn = WeightCC * (CorrCoef - CCMin)/(CCMax - CCMin) +
               WeightEq * (TotProf - EqMin)/(EqMax - EqMin);

    { write correlation coefficient to file along with system
parameters }
    StrOut = NumtoStr(ObjectFn, 2) + ", " + NumtoStr(TotProf, 2) + ", "
+ NumtoStr(CorrCoef, 3) + ", " +
             NumtoStr(Param1, 3) + ",  " + NumtoStr(Param2, 3) + ",  "
+  NumtoStr(Param3, 3) + ",  " +
             NumtoStr(Param4, 3) + ",  " + NumtoStr(Param5, 3) +
Newline;
    FileAppend(FName, StrOut);
 End;

 EqtyCorr = CorrCoef;
```

The first five inputs to the function, Param1, Param2, ..., Param5, represent the input parameter values for the system being optimized. Because it's difficult to optimize more than five inputs simultaneously in TradeStation, I've limited the inputs to five. When optimizing fewer than five, simply set the others to zero. If you do the optimization in steps, a different output file can be used for each optimization, and Param1 - Param5 can be set to different input parameter values each time.

The inputs CCMin and CCMax are the minimum and maximum values of the correlation coefficient, represented by Rmin and Rmax in the equations above. The inputs EqMin and EqMax correspond to the equation variables PWmax and PWmin above. Similarly, inputs WeightCC and

WeightEq correspond to OW1 and OW2 above. The multiplying factor that determines how much more recent equity changes are weighted compared to earlier ones -- represented by variable M in the equations -- is given in the code by the variable PWFact. This could be changed to a function input if you wanted to be able to change it more readily.

To see how this function can be used, the code below shows how it's called in the simple channel breakout trading system I mentioned earlier, which was applied to the Yen.

```
{
 Simple Channel BO (breakout) system, based on TradeStation systems
 Channel Breakout LE and Channel Breakout SE.
}
input: Length(50);

Buy ("ChBrkLE") next bar at HighestFC(High, Length) + 1 point stop;
Sell Short ("ChBrkSE") next bar at LowestFC(Low, Length) - 1 point
stop;

Value1 = EqtyCorr(Length, 0, 0, 0, 0, .52, .945, 2400, 72000, 1, 10,
"C:\bcm\TestCC.txt");
```

The function is called in the last line of the code. Because this system has only one input, the function inputs Param2 - Param5 are set to zero. The next two function inputs are the minimum and maximum values of the correlation coefficient. The next two are the minimum and maximum values of the weighted net profit. Following those are the weights for the correlation and net profit terms of the objective function, respectively. Here, I'm weighting the profit term higher than the correlation term. I'm doing this because I've set the net profit weighting factor (PWFact in the code or variable M in the equations above) to a high value (100). I'm hoping that by weighting the more recent part of the equity curve much higher than the earlier part that the optimization will value parameter sets higher that have high equity values at the end of the equity curve. If this works, the optimal result should produce an equity curve that is profitable in recent years, unlike the equity curve shown above.

Let's see how it does. I optimized the system shown above over input values (channel lengths) of 5 to 90 in increments of 1. This produced the output file TestCC.txt shown below.

```
-7.17, -33322.26, -0.344, 5.000,  0.000,  0.000,  0.000,  0.000
1.55, 12573.79, 0.558, 6.000,  0.000,  0.000,  0.000,  0.000
5.30, 33526.75, 0.874, 7.000,  0.000,  0.000,  0.000,  0.000
-5.83, -24832.22, -0.296, 8.000,  0.000,  0.000,  0.000,  0.000
4.16, 26840.19, 0.797, 9.000,  0.000,  0.000,  0.000,  0.000
5.92, 38072.43, 0.857, 10.000,  0.000,  0.000,  0.000,  0.000
4.47, 30434.27, 0.707, 11.000,  0.000,  0.000,  0.000,  0.000
8.42, 54830.40, 0.895, 12.000,  0.000,  0.000,  0.000,  0.000
7.61, 48549.36, 0.936, 13.000,  0.000,  0.000,  0.000,  0.000
6.84, 43517.97, 0.915, 14.000,  0.000,  0.000,  0.000,  0.000
6.80, 42783.76, 0.945, 15.000,  0.000,  0.000,  0.000,  0.000
3.23, 19308.60, 0.861, 16.000,  0.000,  0.000,  0.000,  0.000
3.13, 18605.73, 0.862, 17.000,  0.000,  0.000,  0.000,  0.000
0.59, 2304.74, 0.775, 18.000,  0.000,  0.000,  0.000,  0.000
...
...
```

The first column is the value of the objective function. The second column is the weighted net profit, the third is the correlation coefficient, and the fourth is the input parameter -- channel length. The remaining columns are the unused system input parameter values. I then opened this file in Excel and sorted the results by the first column in descending order, which produced the following table:

8.42	54830.4	0.895	12	0	0	0	0
7.61	48549.36	0.936	13	0	0	0	0
6.84	43517.97	0.915	14	0	0	0	0
6.8	42783.76	0.945	15	0	0	0	0
6.5	40627.96	0.949	26	0	0	0	0
6.5	40547.87	0.955	27	0	0	0	0
6.46	40398.79	0.945	28	0	0	0	0
6.02	37587.1	0.931	34	0	0	0	0

…

…

The highest value of the objective function, 8.42, is on top. The corresponding value of the channel length, 12, is our optimal channel length. The following chart shows the equity curve for this system using the optimal channel length of 12.

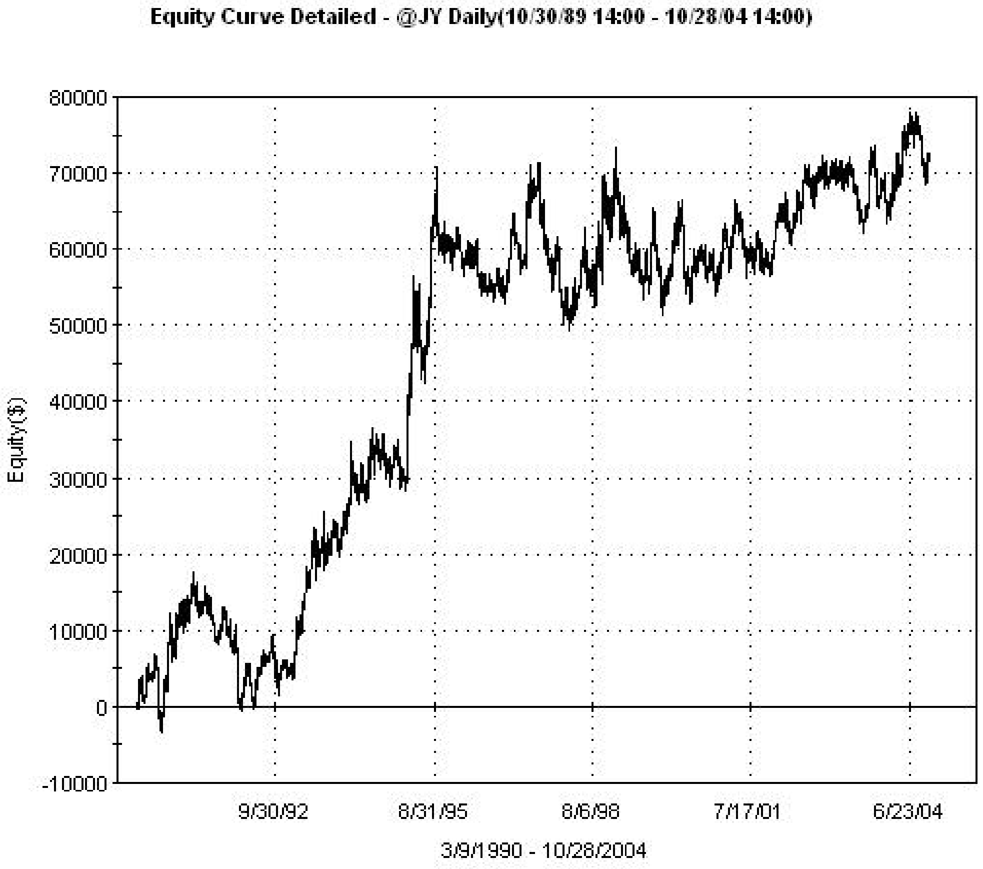


Fig. 2. Equity curve for channel breakout system with a channel length of 12 bars, obtained by optimizing the weighted net profit and correlation coefficient.

Notice how the equity curve is profitable in recent years (the peak is July 2004), unlike the previous equity curve, which declined after a peak in 2002. The objective function worked as intended. By weighting the equity changes higher in recent years, the parameter value that produced the best results in recent years produced the highest value of the objective function. And the equity curve is still fairly straight overall because we included the term based on the correlation coefficient.

Since we've included the correlation coefficient in the output file, we can sort the data by correlation coefficient (column C) to see which parameter value would produce the straightest looking equity curve. Here's the file sorted by correlation coefficient:

```
6.5   40547.87   0.955   27   0 0 0 0
6.5   40627.96   0.949   26   0 0 0 0
6.8   42783.76   0.945   15   0 0 0 0
6.46   40398.79   0.945   28   0 0 0 0
5.37   32835.54   0.944   29   0 0 0 0
7.61   48549.36   0.936   13   0 0 0 0
4.86   29413.79   0.935   23   0 0 0 0
3.68   21239.09   0.932   30   0 0 0 0
6.02   37587.1   0.931   34   0 0 0 0
...
...
```

The parameter value that produces the highest correlation coefficient is 27. The corresponding equity curve is shown below.

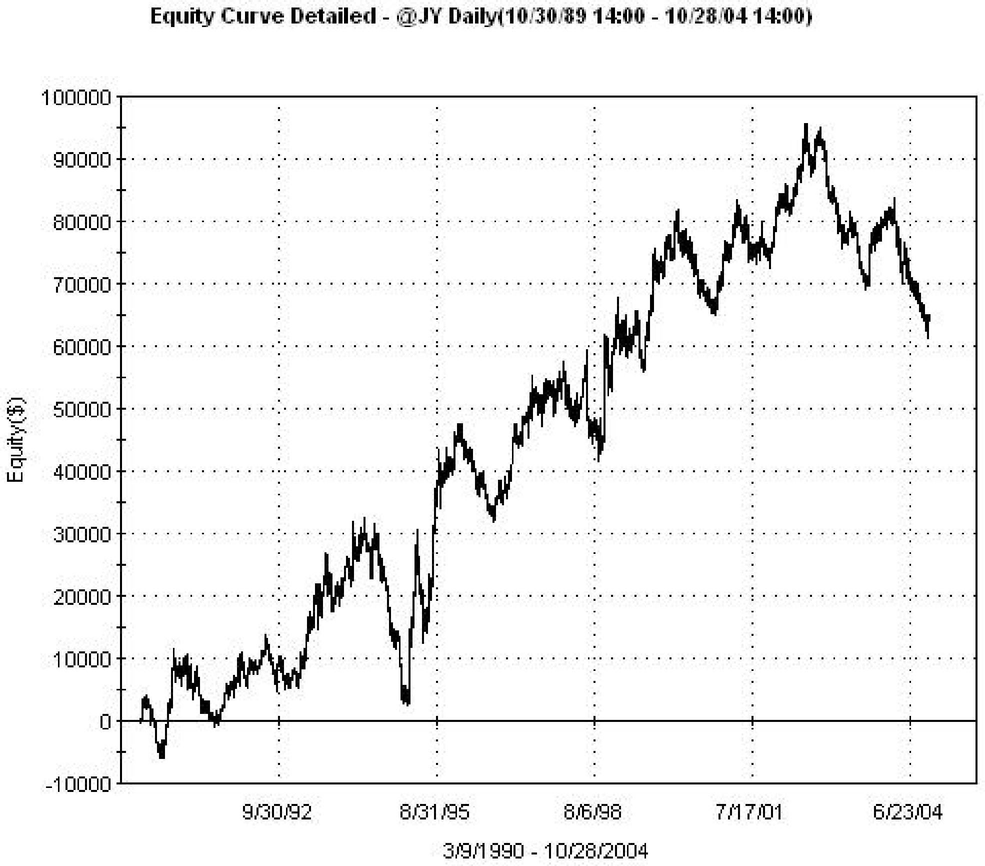


Fig. 2. Equity curve for channel breakout system with a channel length of 27 bars, obtained by optimizing the correlation coefficient.

Notice that the equity curve is nearly a straight line -- aside from the usual wiggles -- up until the peak, which occurs in July 2002. The system has been in a drawdown since the peak using this parameter value, so optimizing based on correlation coefficient alone doesn't solve the original problem of poor recent performance.

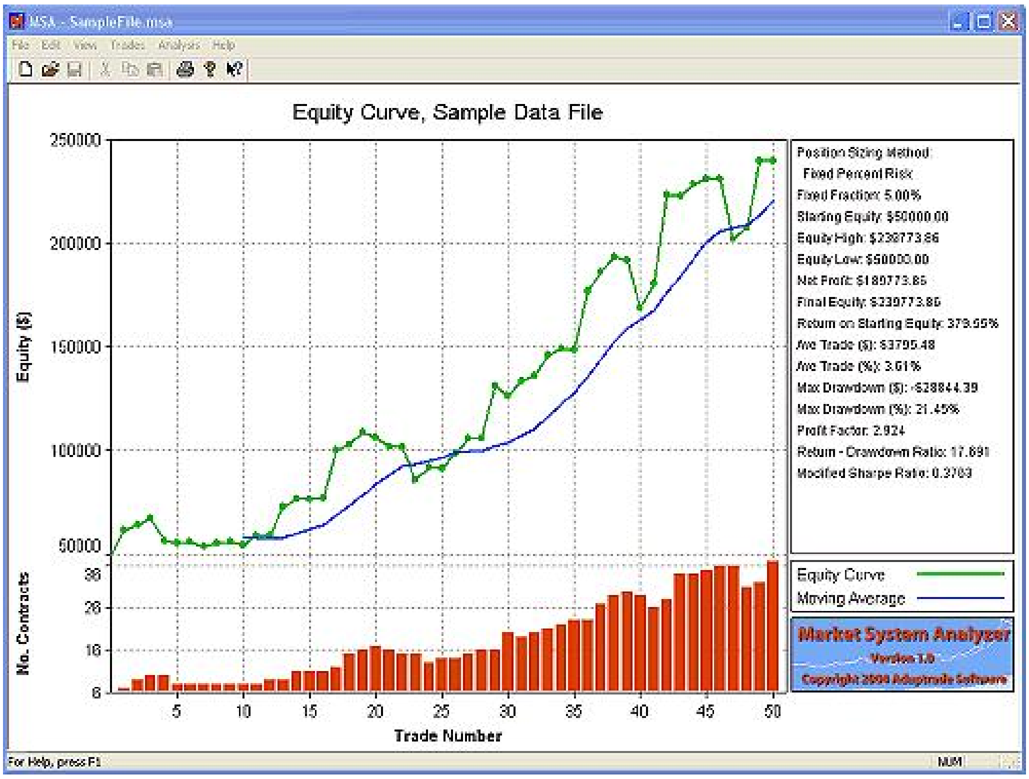
The EqtyCorr function can be added to any TradeStation trading system to provide an alternative to the optimization objectives available in TradeStation. Of course, just because the equity curve is a straight line and the most recent part of the equity curve is profitable is no guarantee that the system will be profitable going forward. However, I'd rather trade a system like that than one in which the equity curve has been in a protracted drawdown. As mentioned earlier, it's best to optimize over as many trades as possible. The EqtyCorr function makes it easier to find good results over a long sample of trades.

My Latest Project: Market System Analyzer

At the beginning of this newsletter, I mentioned that I recently developed a Windows program for trading system analysis and money management. My new software, called Market System Analyzer, is designed to help traders get the most out of their current approach to trading the markets. The program performs a series of analyses on an existing trading system or method with the goal of helping traders:

- Reduce drawdowns.
- Raise the percentage of winning trades.
- Learn when to increase position size and when to scale back.
- Discover profitable patterns in their systems and learn how to exploit them.
- Keep up with shifting market conditions by detecting changes in the profit/loss pattern of their trading.

I've included all of my favorite methods and ideas for position sizing, system testing and evaluation, and money management. Anyone who's read a few of my newsletters probably knows that I'm a big believer in money management methods. Many of the topics I've addressed in past newsletter issues are included in the software as analysis features. The result is a collection of powerful analysis tools that you can apply to any trading system or method. This combination of tools is not available anywhere else, and some of these tools are unique to Market System Analyzer. All the features and options in the program have been designed to work together, resulting in a number of new and intriguing ways to trade.



Position Sizing Method:
Fixed Percent Risk
Fixed Fraction: 5.00%
Starting Equity: $50000.00
Equity High: $239773.86
Equity Low: $50000.00
Net Profit: $189773.86
Final Equity: $239773.86
Return on Starting Equity: 379.55%
Ave Trade ($): $3795.48
Ave Trade (%): 3.61%
Max Drawdown ($): -$28844.39
Max Drawdown (%): 21.45%
Profit Factor: 2.924
Return - Drawdown Ratio: 17.891
Modified Sharpe Ratio: 0.3703

Main window of Market System Analyzer.

Perform Advanced Analyses:

- Five position sizing methods,including fixed fractional and fixed ratio position sizing, and three options for applying position sizing.
- A randomization feature that lets you visualize the effect of trade order on trading performance.
- Position sizing optimization so you can maximize your trading performance using any of the available position sizing methods.
- Monte Carlo analysis with detailed performance reporting.
- A parameter studies feature that lets you plot position sizing parameters against any of eight performance measures.

- Dependency analysis to determine if your trading system or method has a statistically significant tendency to form runs of wins or losses.
- Dependency rules to exploit any trade dependency that may exist.
- Significance testing to determine the likelihood that your trading system or method is inherently profitable.
- A unique equity curve crossover feature with rules for modifying your trading based on crossovers of the equity curve with its moving average.
- Detailed performance statistics that account for all position sizing and analysis settings and options.
- EasyLanguage code for TradeStation to generate input files for Market System Analyzer and to implement any of the available position sizing methods in TradeStation systems.

Easily Enter and Manipulate Data:

- Import trade profit/loss and/or risk data from a text file.
- Duplicate or create a series of trades from a set of performance statistics.
- Specify a trade risk value in one of four ways and assign it to all trades.
- Edit/add/delete trade and risk data.
- Export trade and risk data.

Tailor the Analysis to Your Needs and Preferences:

- Save a segment of data for out-of-sample testing.
- Automatically perform walk-forward position sizing optimization.
- Perform dependency analysis on a user-selected sliding window of trades.
- Save analysis reports.
- Format the chart window: change fonts, line and bar colors, grid, title, etc.

Market System Analyzer can be used for several different purposes:

- To test and evaluate trading systems and methods.
- For day to day trading decisions -- to decide whether to take an upcoming trade and, if so, how many contracts or shares to trade.
- As an educational tool.

Market System Analyzer (MSA) analyzes market systems in terms of their profit/loss records. The program is designed to extract the maximum amount of information from the minimum amount of input data. And all analysis features in MSA are accessible from simple menu commands, making it easy to perform powerful analyses without any programming or lengthy data input.

The software is designed for both individual and professional traders. The familiar Windows interface makes the program easy to use, and detailed help files are available if needed to explain how to use each analysis feature. To get started, all you need is a list of profit/losses for the trading system or method you want to analyze.

Because you're a customer of Breakout Futures, you can purchase Market System Analyzer for only $99.00 for a limited time. That's $50 off the introductory price of $149, which I intend to increase in the near future. I've setup a special link, hidden from the general public, for this pricing. You'll be able to download the file and be up and running in minutes if you follow this link: http://www.adaptrade.com/specialoffer091604.htm

To learn more about Market System Analyzer, visit http://www.adaptrade.com/product.htm. Just remember to use the link shown above to get the special pricing.

That's all for now. Good luck with your trading.

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