Measuring System Performance

Want to improve the evaluation of your trading systems? Here's a new performance measure that uses some statistics to measure profitability through time.

by Lars N. Kestner

Starting with an idea and developing a trading system is a relatively simple and straightforward process. Because it is a simple process, it is possible to create numerous systems in a short time. Since trading is a profit-oriented

process, our interest lies in the performance of the best systems created, not the number of systems created. How, then, can performance be determined in order to select the optimal system? Looking at total profits is a major part of this question, but other factors are perhaps as important, if not more. Consistency of profits is probably the most influential factor in performance. Basing performance evaluation on consistency of returns can provide better insight to our ultimate question: *How will the system perform in the future* ?

Many measures exist to quantify trading system performance, but all have certain weaknesses. Some can be biased by one or two big trades, while some do not account for risk properly. Some are biased by correlation in returns, while others are not comparable over different periods. I have developed a new method of evaluating performance that is more robust than current popular techniques. This method, which maintains the idea of measuring reward as compared with risk, utilizes more advanced statistical techniques to quantify performance. Rather than simply looking at returns independently, consistency of results through time will be the focal point of this new performance method.

The new measure, which I call the K-ratio, works with the equity curve of a system. An equity curve is simply a chart of accumulated profits through time. A mathematical model must be created for equity to calculate the components of the new method. In the model, equity on any day is explained solely by its distance from the start of the test.

Equity model: $Equity_i = b_0 + (b_1)(Observation_i)$

$= \{ Y = b_0 + b_1 x \}$

where $Equity_i$ is the cumulative equity on $observation_i$

(The K-ratio can be calculated from a daily, weekly or monthly equity curve.)

The numerator of the K-ratio is the b_1 coefficient estimate in the equity model. The b_1 estimate is the ratio's proxy for return and is calculated by running an ordinary least-squares regression on the equity model. The value of b_i is also the slope of the least-squares trendline from the equity curve. The higher the values of b_1, the sharper the rise in the equity curve is and the faster the system makes money. Risk of the trading system is measured by the standard error of b_1, again calculated from linear regression techniques. The standard error of b_1 measures the efficiency of the equity model. Higher standard errors indicate inconsistent performance; the model did not explain daily equity values successfully. Lower standard errors indicate stability in returns. Finally, the standard error of b_1 is multiplied by the square root of the number of observations in the equity curve. This normalizes the K-ratio to be comparable across time frames (one year, five years, 10 years) and periodicity of data (daily, weekly, monthly). Those more familiar with statistics will recognize the K-ratio as the t -statistic of b_1 with a correction factor for the number of observations.

CALCULATIONS
Although this process appears complicated, the ratio can be completed quite easily in a spreadsheet (Figure 1). Figure 2 is a sample 20-day equity curve. The graph begins at $0 at day 1 and rises to approximately $10 on day 20. Solving the equity model by the use of least squares is equivalent to fitting a trendline through the equity curve. At a hypothetical day zero, the value of the trendline will be b_0. The trendline will then increase by b_1 with each unit increase in time.

For system 1:

$$Equity_i = -0.75 + 0.58 \, x \; Observation_i, \text{ with the standard error of } b_1 = 0.022$$

$$System1's \, K-ratio = \frac{0.58}{0.022\sqrt{20}} = 5.90$$

Typical values of the K-ratio fall between -5 and +5. Extreme positive values establish that a system's results are positive and stable, while exceptionally negative K-ratio results demonstrate undesirable negative performance. Values closer to zero indicate that the system possesses only marginal profits and losses and/or that the profit stream

is highly inconsistent.

	A	B	
	Workbook1		
	A	**B**	
1	1	0.00	
2	2	-0.15	
3	3	0.72	
4	4	1.23	
5	5	2.50	
6	6	2.33	
7	7	2.54	
8	8	3.63	
9	9	4.91	
10	10	6.25	
11	11	6.32	
12	12	6.60	
13	13	6.75	
14	14	7.92	
15	15	8.30	
16	16	9.00	
17	17	9.22	
18	18	9.36	
19	19	9.37	
20	20	10.17	
21	K-Ratio=	5.90	
22			
23			
	Sheet 1		

FIGURE 1: K-RATIO IN EXCEL. *Place the observation number in column A and then place the equity curve values in column B. The K-ratio is calculated in cell B21:*
=SLOPE(B1:B20,A1:A20)*SQRT(DEVSQ(A1:A20))/STEYX(B1:B20,A1:A20)/SQRT(20)

The K-ratio can be calculated from the equity curve of a single commodity or portfolios of commodities. The only restriction is that the contract sizes used in the tests should be consistent over the life of each test. Trading more contracts because of accrued system profits will lead to an exponential equity curve, while the ratio seeks a linear relationship between time and profit. I would recommend testing systems over as much data as possible, as this will increase the validity of K-ratio results. I look for systems with an average K-ratio of 1.0 or better for individual commodities, and values of 3.0 or higher for diversified portfolios of commodities. Portfolios will typically have higher K-ratios than individual commodities due to diversification. Although I recommend calculating the K-ratio using daily performance figures, in some cases this may result in too much data for even the fastest computers to handle. In these cases, calculating the K-ratio from a weekly or monthly equity curve would be advisable.

The K-ratio detects inconsistency in returns. System 1 (shown in Figure 2) and system 2 (shown in Figure 3) both return approximately $10 over the 20-day time frame. So which is better? Solving the equity model for system 2 yields a b_1 estimate of 0.55 with a standard error of 0.068.
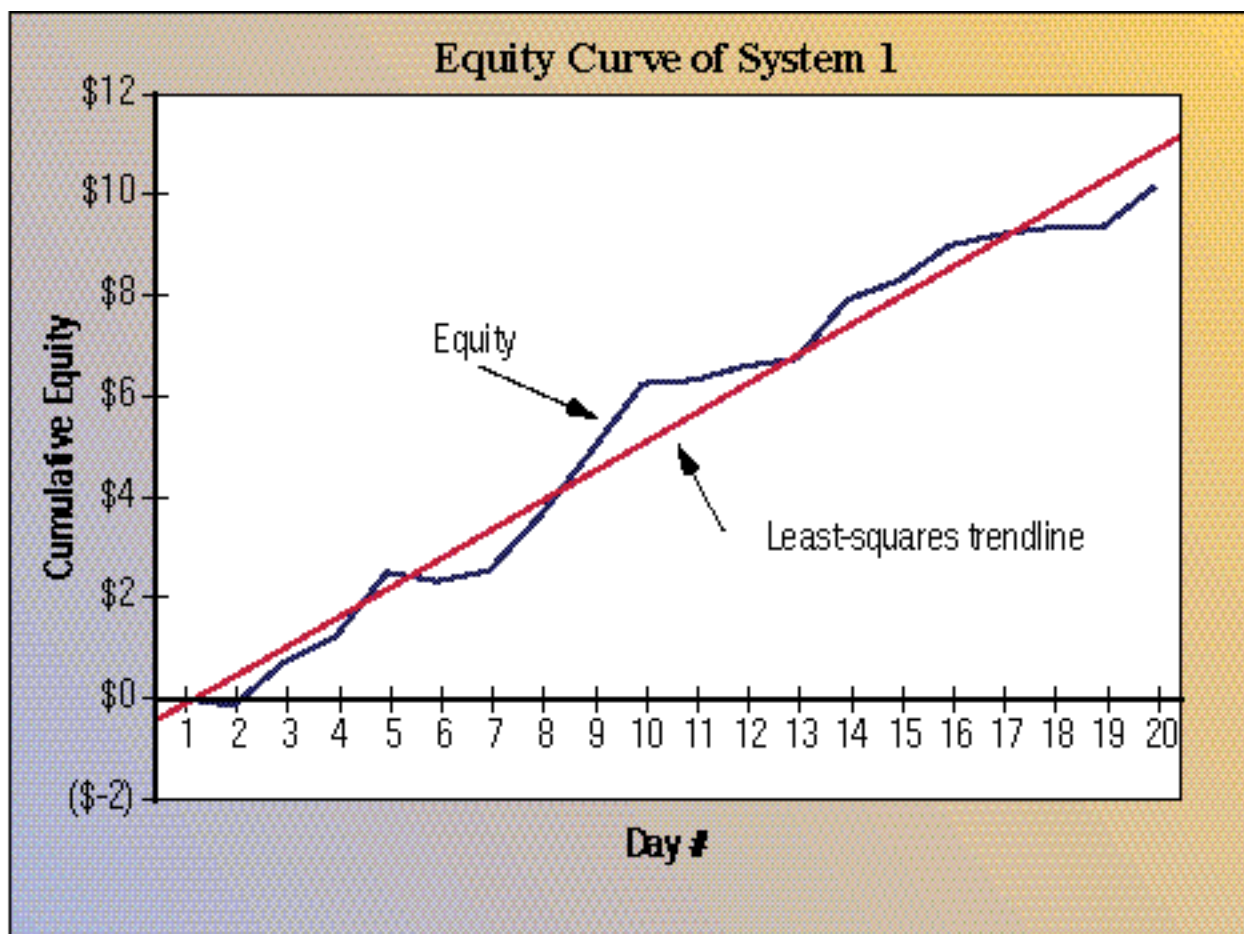
FIGURE 2: EQUITY CURVE OF SYSTEM 1. *The slope of the equity curve is 0.58. (The slope is 0.58, the equation for the trendline is -0.75 + 0.58 x.) System 1's least-squares trendline fits the equity curve tightly, suggesting consistency in returns.*
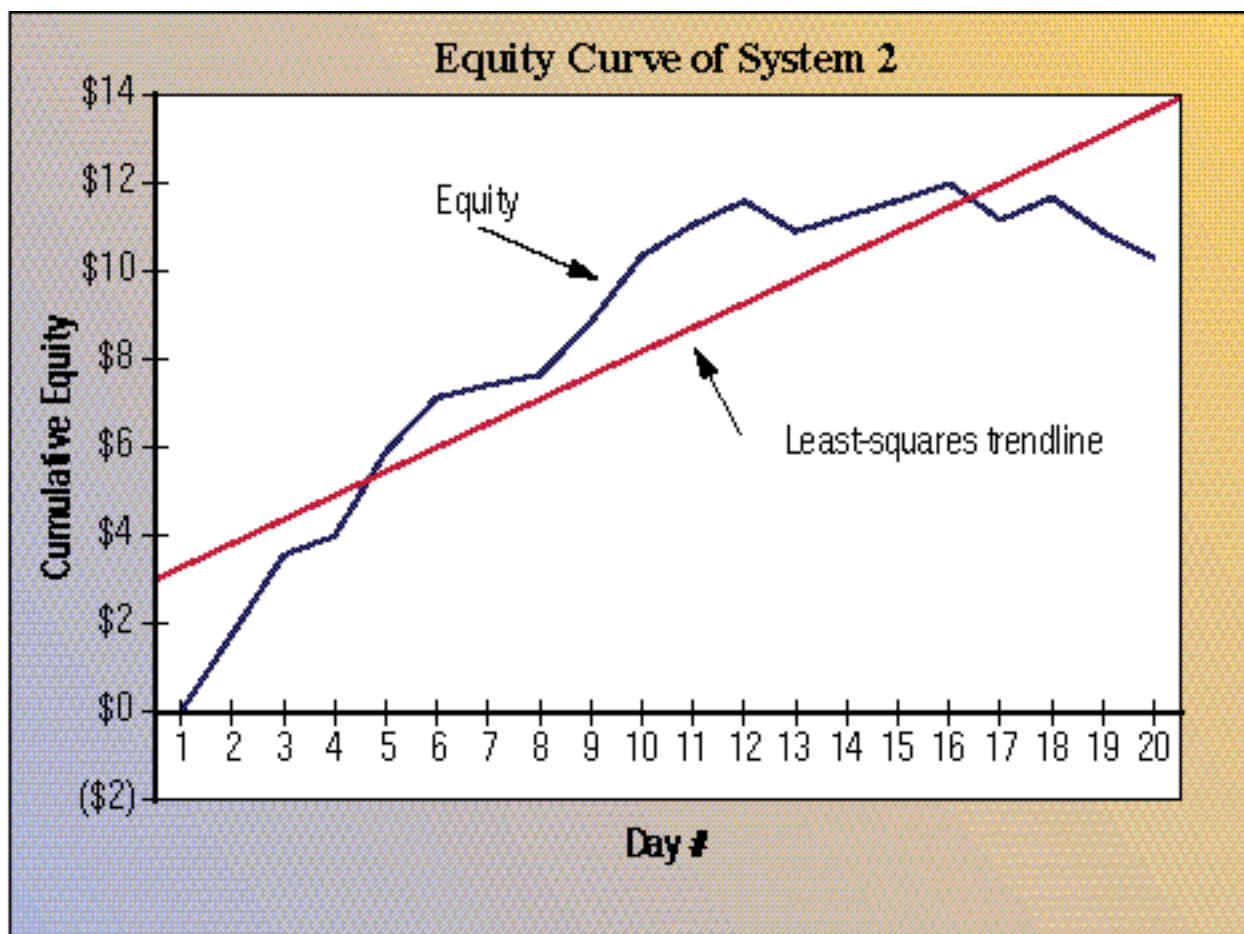
FIGURE 3: EQUITY CURVE OF SYSTEM 2. *The slope of the equity curve is 0.55. (The slope is 0.55, the equation for the trendline is 2.73 + 0.55 x.) System 2's least-squares trendline does not fit the equity curve as well, suggesting less consistency in returns.*

Although both systems have similar returns as measured by b_1 estimates, system 1 has a much lower standard error. System 1 has a higher K-ratio and therefore possesses better reward to risk than system 2. This observation is best demonstrated by viewing the equity curves and their corresponding least-squares trendlines. In Figure 2, system 1's trendline fits the equity curve tightly, while in Figure 3, system 2's trendline does not, suggesting returns were less consistent than that of system 1. System 1 is the preferred system.

The K-ratio is a tremendously powerful measure of system performance that provides a far more robust estimate than current popular techniques. (For TradeStation users, see sidebar, "K-ratio TradeStation code.") At the same time, it is easy to calculate. Computing the ratio for the systems you develop can save a lot of time weeding out the good systems from the bad. Remember, the goal of trading is to profit from your systems, not to spend all your time designing and testing them. Learning to use the K-ratio can save you time and improve your bottom line.

THE K-RATIO TRADESTATION CODE

The K-ratio system includes no buy or sell signals. When run simultaneously with other trade-generating systems, it prints the K-ratio of the trade-generating system to the print log window.

```
System Name : K-ratio

VAR: Observation(0), Count(0), SumXY(0), SumX(0), SumY(0), SumXSqr(0);

VAR : Beta0(0), Beta1(0), SumResidSqr(0), SigmaRegress(0), StandardErrB1(0);
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```
VAR: StandardErrB1Denom(0), YProjected(0), KRatio(0);

ARRAY: Equity[5000](0);

Observation = Observation+1;

Equity[Observation] = NetProfit + OpenPositionProfit;

IF Date = LastCalcDate THEN

BEGIN

For Count = 1 TO Observation

BEGIN

SumXY = SumXY + ( Count * Equity[Count] );

SumX = SumX + Count;

SumY = SumY + Equity[Count];

SumXSqr = SumXSqr + ( Count * Count );

END;

Beta1 = ( SumXY - ( SumX * SumY ) / Observation ) /

( SumXSqr - ( SumX * SumX ) / Observation );

Beta0 = ( SumY / Observation ) - Beta1 * ( SumX / Observation );

For Count = 1 TO Observation

BEGIN

YProjected = Beta0 + ( Beta1 * Count );

SumResidSqr = SumResidSqr + SQUARE( Equity[Count] - YProjected );

StandardErrB1Denom = StandardErrB1Denom + SQUARE( Count - ( Observation + 1 ) / 2 );

END;

SigmaRegress = SQUAREROOT( SumResidSqr / ( Observation - 2 ));

StandardErrB1 = SigmaRegress / SQUAREROOT ( StandardErrB1Denom );

KRatio = Beta1 / ( StandardErrB1 * SQUAREROOT( Observation ));

Print( "K-ratio = ", KRatio:4:2);

END;
```

-L.N.K.

Lars Kestner is founder of LINK Financial, a firm specializing in trading system development and applications for Omega Research software users.