

MONEY MANAGEMENT

# Evaluating System Efficiency

**TRADES**

| Trade | Date   | Type      | Price |
|-------|--------|-----------|-------|
| 1     | 970310 | Buy       | \$10  |
|       | 970312 | Exit/Long | \$15  |
| 2     | 970317 | Buy       | \$10  |
|       | 970319 | Exit/Long | \$15  |
| 3     | 970324 | Buy       | \$10  |
|       | 970326 | Exit/Long | \$15  |

**FIGURE 1:** Here are the entry and exit prices of three hypothetical trades.

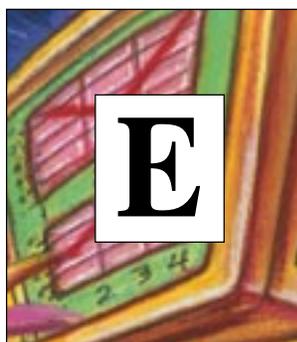
**MARKETS**

| Date   | Open | High | Low | Close |
|--------|------|------|-----|-------|
| 970310 | 10   | 12   | 10  | 11    |
| 970311 | 11   | 13   | 11  | 12    |
| 970312 | 12   | 15   | 12  | 15    |
| 970317 | 10   | 15   | 10  | 13    |
| 970318 | 13   | 17   | 13  | 17    |
| 970319 | 17   | 19   | 15  | 15    |
| 970324 | 10   | 10   | 7   | 8     |
| 970325 | 8    | 8    | 5   | 5     |
| 970326 | 5    | 15   | 8   | 15    |

**FIGURE 2:** Here's the market action during the time each trade from Figure 1 was in place.

We've all experienced good trades, bad trades and so-so trades. Wouldn't it be better if you had steps you could take to improve the entries and exits of the trades that your system generated? This article shows you how.

by Leo J. Zamansky, Ph.D., and David C. Stendahl

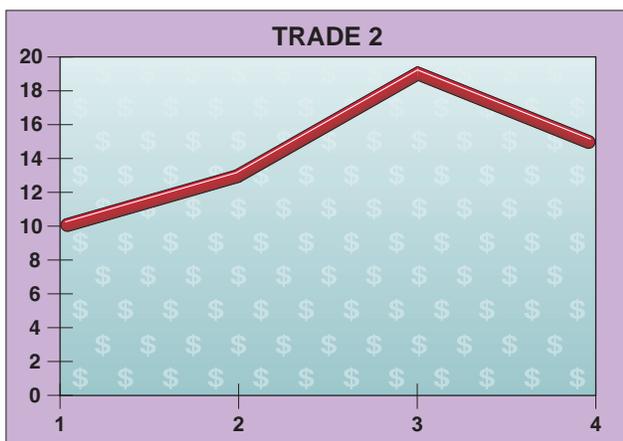


Evaluating a trading system performance is not a trivial task. Not only does a trader need to know how much money the system has made but also *how* the system made the money. A system may be extremely profitable, but if it does not match the preferences of the trader using it, the trader may not take advantage of its capabilities and in turn be disappointed with the results. Evaluating a trading system is also necessary from a technical point of view to calculate the system's performance characteristics to be able to improve on them later. Efficiency of trading serves exactly that purpose.

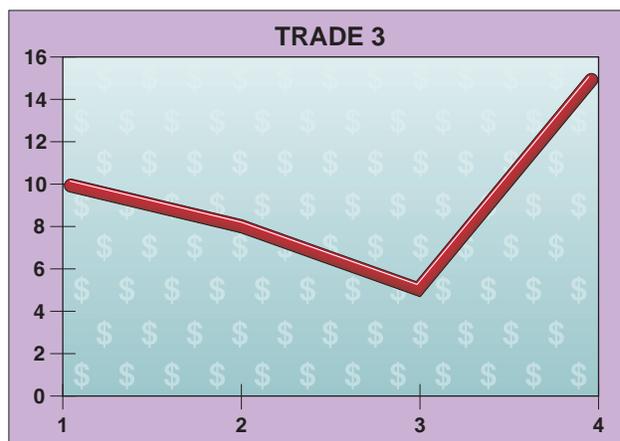
Let us consider three trades (Figure 1). Let us assume that this is an end-of-day system that entered on the open on the first day and exited on the close on the last day. The results below are equally applicable to the intraday systems as well. Duration, number of contracts/shares and profits are the same for all trades. Now, let us also consider the behavior of the market traded during each trade in Figure 2.



**FIGURE 3: TRADE 1.** The first trade enjoyed a steady increase in equity.



**FIGURE 4: TRADE 2.** The second trade gave back a portion of the unrealized profit prior to the exit signal.



**FIGURE 5: TRADE 3.** While in the third trade, there was an unrealized loss and then the trade became profitable.

Even though all three trades have the same duration, started from the same price and made the same profit, clearly, there are notable differences between them. Trade 1 went from \$10 to \$15 without a decline and exited at the top (Figure 3). Trade 2 went from \$10 to \$19, and then when it dropped to \$15, the system generated an exit signal (Figure 4). Trade 3 dropped from \$10 to \$5, and then, when it rose to \$15, an exit signal was triggered (Figure 5). During trade 1, the system realized the full potential of the market traded. During trade 2, the system captured the entry point well but exited late, giving away a portion of the profit potential. The entry for trade 3, on the other hand, was very early, but the exit was at the top.

### EFFICIENCY DEFINITION

*Total efficiency* is defined as a realized difference in prices from a trade expressed as a part of the total profit potential during that trade. It shows how well the total move of a trade has been used. The following formula is used to compute total efficiency:

$$\text{Total Efficiency} = (\text{Realized Difference in Prices}) / (\text{Profit Potential})$$

Realized difference in prices is the difference between exit price and entry price, taking into account the direction of the trade. Profit potential is the difference between the highest and the lowest prices during the trade. To summarize:

*For long trades:*

$$\text{Total Efficiency} = (\text{Exit Price} - \text{Entry Price}) / (\text{Highest Price} - \text{Lowest Price})$$

*For short trades:*

$$\text{Total Efficiency} = (\text{Entry Price} - \text{Exit Price}) / (\text{Highest Price} - \text{Lowest Price})$$

Now with that in mind, let's analyze the trades in Figure 1.

*For trade 1:*

$$\text{Total Efficiency} = (15 - 10) / (15 - 10) = 1 \text{ (or 100\%)}$$

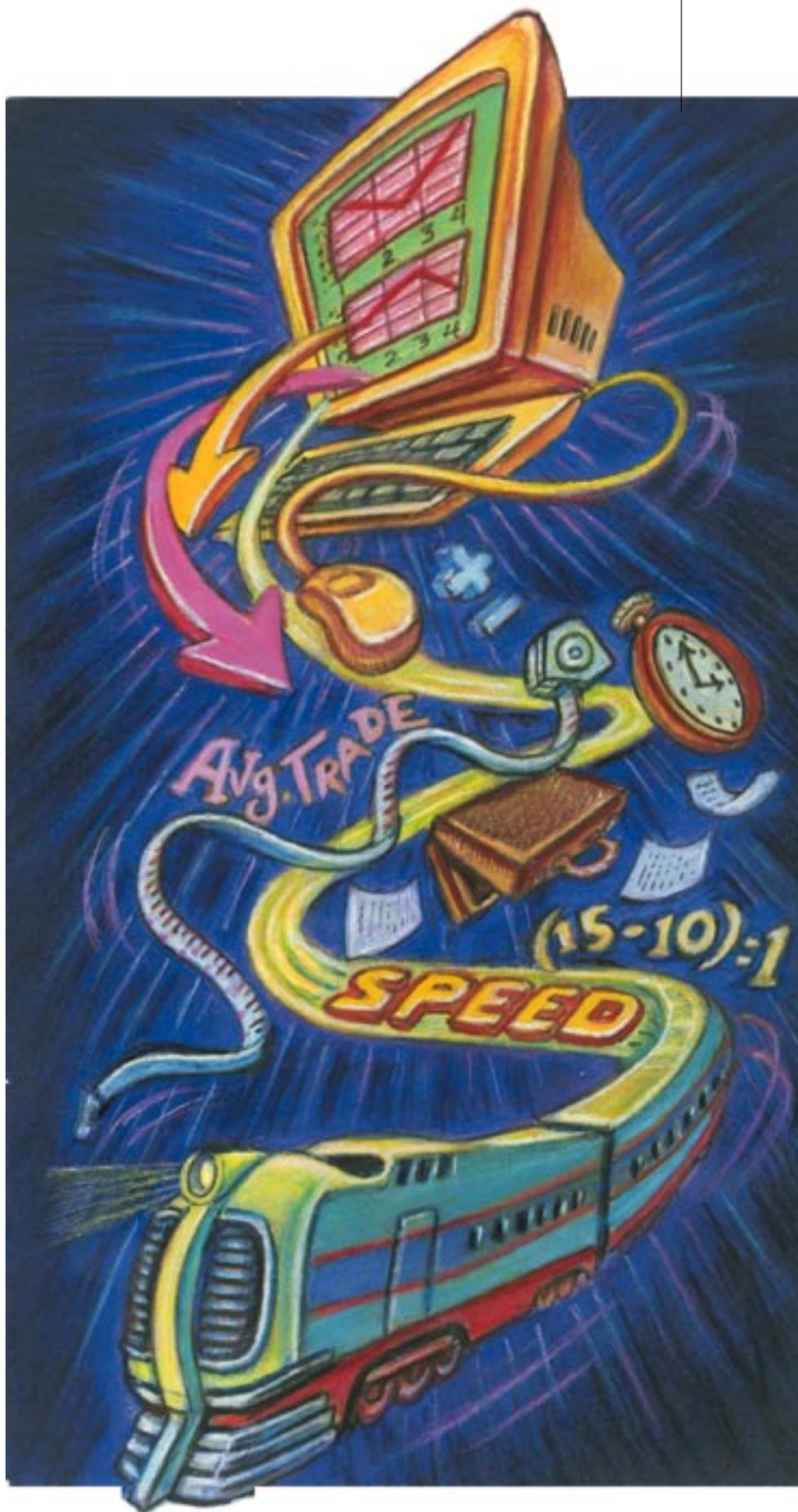
*For trade 2:*

$$\text{Total Efficiency} = (15 - 10) / (19 - 10) = 0.556 \text{ (or 55.6\%)}$$

*For trade 3:*

$$\text{Total Efficiency} = (15 - 10) / (15 - 5) = 0.5 \text{ (or 50\%)}$$

Total efficiency ranges from -1 or -100% (minimum) to 1 or 100% (maximum). Posi-



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tive trade efficiency of  $X\%$  means that the trade is profitable and made  $X\%$  of the trade total potential gain. Negative trade efficiency of  $-X\%$  means that the trade lost money in the amount of  $X\%$  of the trade total potential loss.

*Entry efficiency* is defined as a maximum possible realized difference in prices from a trade that has the trade entry price expressed as a part of the total profit potential during that trade. Entry efficiency shows how well a system enters into a trade, if a signal is to go long — how close was the entry to the lowest point within the trading period, if the signal is to go short — how close was the entry to the highest point within the trading period. With that in mind, let's use the following formula to compute entry efficiency for a trade:

$$\text{Entry Efficiency} = (\text{Maximum Possible Difference in Prices For This Entry}) / (\text{Profit Potential})$$

Maximum possible difference in prices for this entry is the difference between the highest close price (for long trade or the lowest close price for short trade) and entry price.

To summarize:

*For long trades:*

$$\text{Entry Efficiency} = (\text{Highest Price} - \text{Entry Price}) / (\text{Highest Price} - \text{Lowest Price})$$

*For short trades:*

$$\text{Entry Efficiency} = (\text{Entry Price} - \text{Lowest Price}) / (\text{Highest Price} - \text{Lowest Price})$$

For the trades in Figure 1:

*Trade 1:*

$$\text{Entry Efficiency} = (15 - 10) / (15 - 10) = 1 \text{ (or 100\%)}$$

*Trade 2:*

$$\text{Entry Efficiency} = (19 - 10) / (19 - 10) = 1 \text{ (or 100\%)}$$

*Trade 3:*

$$\text{Entry Efficiency} = (15 - 10) / (15 - 5) = 0.5 \text{ (or 50\%)}$$

Entry efficiency changes from zero (minimum) to 1 (maximum).

*Exit efficiency* is defined as a maximum possible realized difference in prices from a trade that has the trade exit price expressed as a part of the total profit potential during that trade. Exit efficiency shows how well a system exits a trade, if a trade is long — how close an exit to the highest point within the trading period, if a trade is short — to the lowest point within the trading period. The following formula is used to compute exit efficiency for a trade:

$$\text{Exit Efficiency} = \frac{\text{Maximum Possible Difference in Prices For This Exit/Profit Potential}}{\text{Profit Potential}}$$

To summarize:

*For long trades:*

$$\text{Exit Efficiency} = (\text{Exit Price} - \text{Lowest Price}) / (\text{Highest Price} - \text{Lowest Price})$$

*For short trades:*

$$\text{Exit Efficiency} = (\text{Highest Price} - \text{Exit Price}) / (\text{Highest Price} - \text{Lowest Price})$$

For the trades in Figure 1:

*Trade 1:*

$$\text{Exit Efficiency} = (15 - 10) / (15 - 10) = 1 \text{ (or 100\%)}$$

*Trade 2:*

$$\text{Exit Efficiency} = (15 - 10) / (19 - 10) = 0.556 \text{ (or 55.6\%)}$$

*Trade 3:*

$$\text{Exit Efficiency} = (15 - 5) / (15 - 5) = 1 \text{ (or 100\%)}$$

Exit efficiency changes from zero (minimum) to 1 (maximum).

It is easy to see that for every trade:

$$\text{Total Efficiency} = \text{Entry Efficiency} + \text{Exit Efficiency} - 1 \text{ (or minus 100\% if in \%)}$$

Both entry and exit efficiencies can be positive but the total efficiency still can be negative, which means the trade lost money. If a sum of entry efficiency and exit efficiency is less than 100%, then total efficiency is negative. If entry efficiency equals 60% and exit efficiency equals 37%, then total efficiency equals -3%. For example, as we know for trade 2:

$$\begin{aligned} \text{Entry Efficiency} &= 1 \text{ (or 100\%)}, \text{Exit Efficiency} = 0.556 \text{ (or 55.6\%)} \\ \text{Total Efficiency} &= 0.556 \text{ (or 55.6\%)} \end{aligned}$$

These calculations can be combined into a report. Figure 6 shows a trade-by-trade report that includes the efficiency calculations.

## EFFICIENCY ANALYSIS

Once the individual trades have been thoroughly evaluated, the next step is to analyze efficiency of a system as a whole. To analyze a system's efficiency, we introduce average total efficiency (or simply, average efficiency), average entry efficiency and average exit efficiency for all trades:

$$\begin{aligned} \text{Average Total Efficiency} &= (\text{Sum of Total Efficiencies for all trades}) / (\text{Number of trades}) \\ \text{Average Entry Efficiency} &= (\text{Sum of Entry Efficiencies for all trades}) / (\text{Number of trades}) \\ \text{Average Exit Efficiency} &= (\text{Sum of Exit Efficiencies for all trades}) / (\text{Number of trades}) \end{aligned}$$

The same rule applies to averages as to trade efficiencies, namely:

$$\text{Average Efficiency} = \text{Average Entry Efficiency} + \text{Average Exit Efficiency} - 1$$

These averages point into the direction of the system improvement. If average entry efficiency is low, then it should be possible to improve the system by changing the entry timing.

The same is true for average exit efficiency. If average total efficiency is low, then both average entry and exit efficiencies must be checked. Have analyzed efficiencies for many different systems, we consider entry and exit efficiencies to be low for a system if they are below 60%. For average total

| Trade # | Date   | Price     | Profit        | % Profit | Run-up Drawdown | Entry Eff. | Exit Eff. | Total Efficiency |
|---------|--------|-----------|---------------|----------|-----------------|------------|-----------|------------------|
| 1       | 850327 | \$182.710 |               |          | \$1,505.005     | 100.00%    |           |                  |
|         | 850402 | \$183.790 | \$540.000     | 0.59%    | \$0.000         | 35.88%     |           | 35.88%           |
| 2       | 850408 | \$182.960 |               |          | \$1,315.002     | 57.93%     |           |                  |
|         | 850418 | \$183.390 | \$215.000     | 0.24%    | (\$954.994)     | 51.54%     |           | 9.47%            |
| 3       | 850408 | \$182.960 |               |          | \$1,315.002     | 57.93%     |           |                  |
|         | 850418 | \$183.390 | \$215.000     | 0.24%    | (\$954.994)     | 51.54%     |           | 9.47%            |
| 4       | 850617 | \$190.520 |               |          | \$2,919.998     | 77.97%     |           |                  |
|         | 850708 | \$194.380 | \$1,930.000   | 2.03%    | (\$825.005)     | 73.57%     |           | 51.54%           |
| 5       | 850809 | \$191.120 |               |          | \$609.993       | 30.42%     |           |                  |
|         | 850823 | \$189.440 | (\$840.000)   | (0.88%)  | (\$1,395.004)   | 27.68%     |           | (41.90%)         |
| 6       | 860106 | \$214.150 |               |          | \$1,589.996     | 30.20%     |           |                  |
|         | 860108 | \$208.970 | (\$2,590.000) | (2.42%)  | (\$3,675.003)   | 20.61%     |           | (49.19%)         |

**FIGURE 6: PORTFOLIO EVALUATOR REPORT.** Each of your systems should be combined into a report for comparison.

efficiency, we consider below 20% to be low.

It is important to avoid outliers in efficiency analysis. A system may have 10 trades, out of which nine have average efficiency of 15% and one has 100%. The average efficiency for the system for all 10 trades will appear to be 23.5%, which is misleading. To identify these cases, we recommend using standard deviation for each efficiency. If standard deviation is high in comparison with the average of efficiency, then the system must be analyzed on a trade-by-trade basis to come up with a better timing for entries and exits. To compare standard deviation with average, we use coefficient of variation:

$$\text{Coefficient of Variation} = \text{Standard Deviation} / \text{Average (in \%)}$$

The smaller this value, the better consistency in trading efficiency one can expect from the system. Most spreadsheets have the capabilities to calculate the average and standard deviation. Figure 7 shows an example of system efficiency analysis.

### CONCLUSIONS

Trading efficiency offers traders the ability to look separately at the quality of their entries and exits as well as the total trades. Low efficiency points into the direction of trading performance improvement. Low entry efficiency means that

| Efficiency Analysis      |        |                          |                  |
|--------------------------|--------|--------------------------|------------------|
| <b>Total Efficiency</b>  |        |                          |                  |
| Average Total Efficiency | 29.84% | Avg. trade ± 1 STDEV     | 69.79% / -10.11% |
| 1 Std. Deviation (STDEV) | 39.95% | Coefficient of variation | 133.90%          |
| <b>Entry Efficiency</b>  |        |                          |                  |
| Average Entry Efficiency | 65.32% | Avg. trade ± 1 STDEV     | 94.01% / 36.64%  |
| 1 Std. Deviation (STDEV) | 28.68% | Coefficient of variation | 43.91%           |
| <b>Exit Efficiency</b>   |        |                          |                  |
| Average Exit Efficiency  | 64.51% | Avg. trade ± 1 STDEV     | 85.45% / 43.58%  |
| 1 Std. Deviation (STDEV) | 20.93% | Coefficient of variation | 32.45%           |

**FIGURE 7: PORTFOLIO EVALUATOR EFFICIENCY ANALYSIS.** Divide the standard deviation of the efficiency by the average efficiency of the trades to determine the coefficient of variation. The lower the number is, the better.

all entries can be adjusted to improve trading performance. Low exit efficiency means that better exits might be possible. Trading efficiency analysis can be applied to improve both mechanical and nonmechanical trading and to increase one's profit in any market.

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†See Traders' Glossary for definition

