Secure Fractional Money Management

Here's how to find a new fractional value of capital to invest in every trade to maximize returns subject to a constraint on drawdown, using a variation of the optimal f money management strategy.

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

Over the past four years, we have developed and applied evaluation software to trading systems that use money management techniques and have studied the impact of these techniques on trading systems. A new money management strategy called secure *f* is one of the outcomes of that work, and here, we will demonstrate how to find a new fractional value of capital to invest in every trade to maximize returns subject to a constraint on drawdown.

Secure *f* can be a conservative strategy or an aggressive one, depending on the level of acceptable maximum drawdown selected by the trader in question. It is a modification of the optimal *f* strategy that was introduced by Ralph Vince in his *Portfolio Management Formulas*. Secure *f* differs from optimal *f* because it takes historical drawdowns into account and uses information about the prices of the underlying security.

OPTIMAL F

Optimal *f* is a money management strategy that can be used to improve and maximize system performance by finding the best percent of capital to invest in each trade. This strategy determines which percent of equity invested in a trade would have yielded the highest return based on a sequence of past trades. Because traders are able to employ a variety of money management strategies, it can be useful to know what would have been the optimal amount to invest in each case.

The concept of percent or fractional strategy itself comes from the Kelly formula, which estimates the percentage of your capital to trade when the amounts won and lost are not equal:

$$f = ((b+1)p - 1))/b$$

b = Ratio of the size won on a winning bet to the size lost on a losing bet

p = Probability of a winning bet

A simple example would be if you had three bets — two winners and one loser (1, 1, zero) — and you made or lost equal amounts:

$$f = ((1+1)0.666-1)1 = 0.33333$$

This formula solves for *f*. This formula is applicable when there are only two outcomes. For traders, there are many outcomes. Vince introduces optimal *f*, and to find the value of optimal *f*, we need to maximize what Vince calls *terminal wealth relative* (TWR). The problem can be formulated thus:

TWR(f) -> max

where TWR(f)=(HPR1(f))((HPR2(f))(...(HPRn(f))

HPRi(f)=1+(f((-Return on the trade i)/(Return on the worst losing trade))

HPR = Holding period return

Figure 1 illustrates the optimization problem solved by optimal *f*. As we can see from the description of optimal *f* and Figure 1, optimal *f* maximizes the final equity by investing the right amount in every trade. This amount is *f*% of the existing equity at the time the trade is initiated. To find the value of optimal *f*, the calculations are applied to a set of

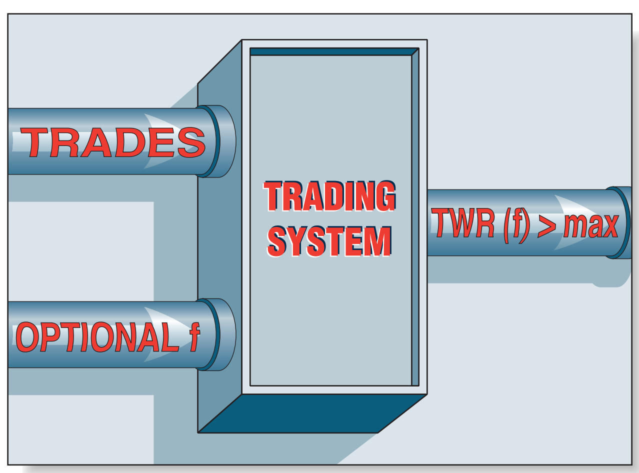

FIGURE 1: OPTIMAL F. The goal is to use optimal f to manage the trading capital so that the terminal wealth relative is maximized.

historical trades. Trade history should be profitable; otherwise, neither optimal *f* nor any other strategy will turn a losing strategy into a winning one. The longer optimal *f* is used, the more final equity will result from its application.

As an example, imagine playing the following game. This game can be viewed as simplified futures trading. You toss a coin in three series, with a total of 11 times each. You pay or get paid only at the end of each series.

To play the game, you need to buy one or more contracts. One contract price is, say, $10,000. A coin-toss is equivalent to a one-point move of the contract. A contract move of one point is, say, $500. If you paid $10,000 for one contract and won eight times and lost three, you made $2,500. Or if you paid $20,000 for two contracts and won seven times and lost four, you made $3,000. In the game you played, for each contract purchased you won six times out of 11 in the first and second series and lost six times in the third. This gives you the results of 1, 1, zero — you won twice and lost once.

The following are the results in each series of your game:

Series 1={1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1}
Series 2={0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1}
Series 3={1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0}

Now, let's say you have $100,000. Let us find the optimal *f* based on the outcomes 1, 1, and zero. You had trades of $500, $500, and -$500:

HPR1=(1+f(500/500))
HPR2=(1+f(500/500))
HPR3=(1-f(500/500))

That gives us the expression for TWR:

$$TWR=(1+f)(1+f)(1-f)=1+f-f^2-f^3$$

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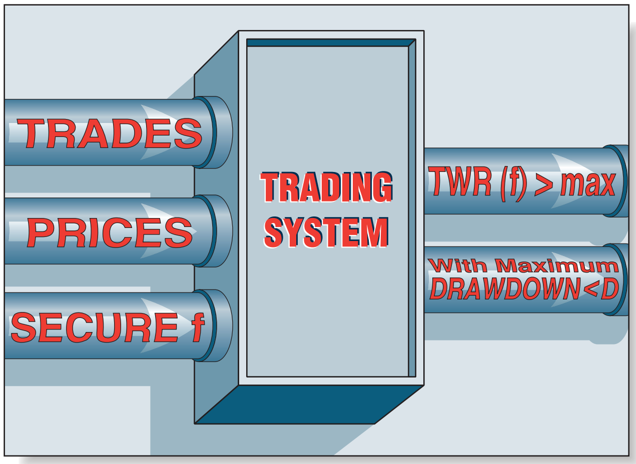


FIGURE 2: SECURE F. The formulation of the problem that includes drawdown is set to a limitation while maximizing terminal wealth relative.

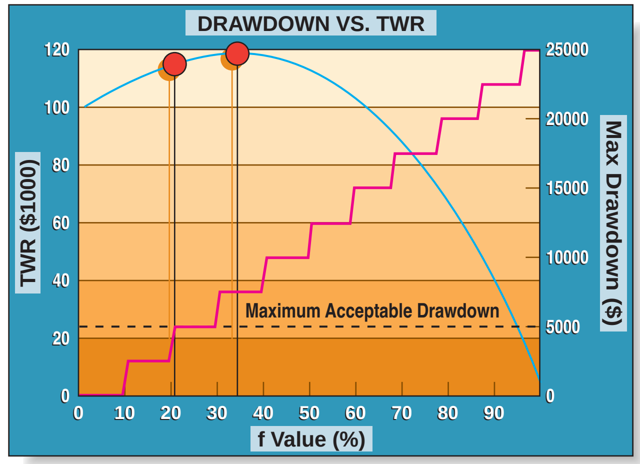


FIGURE 3: RELATIVE COMPARISONS. Here are the terminal wealth relative and maximum drawdown versus f value. As the f value increases, the maximum drawdown also increases. The optimal f peaks at 33.3%. With the maximum drawdown set to $5,000, the secure f values peak at just over 20% of capital.

This function reaches the maximum at $f = {}^1/_3$. This means that optimal *f* tells you to invest in every trade a third of your money, which for the first trade would be $33,333.

Calculate your maximum loss during the game using optimal *f*. That $33,333 will let you buy three contracts, and

> **Secure *f* money management strategy offers traders the ability to maximize the return subject to the level of risk they are willing to assume.**

in the first series, say you win $500 per contract for a total of $1,500. Your total capital after the first series is now $101,500. Again, you use a third of your capital, which is now $33,833, which lets you buy three contracts yet again.

Because you lose $500 for every zero in the series, during the second series, you will be losing $2,500 after the first five moves of the contract. That means that at this moment you have a loss of $7,500 for this series, or a $6,000 total loss of capital. This is 7,500 divided by 101,500 = 0.0739 or 7.39% of the equity at the beginning of the second series. This is the maximum trade drawdown. It is also 6% of the total capital available ($100,000).

As we can see from our calculations, optimal *f* has several drawbacks. First of all, the strategy leads to a rapid expansion in the number of contracts traded. As a rule, this causes unacceptably large drawdowns.

The second limitation of optimal *f* is that it is not psychologically desirable for the average trader concerned with risk. It may also be an unrealistic assumption, depending on the market traded, that the liquidity exists or that the trading system would still be viable given a geometric increase in the number of contracts traded.

Finally, optimal *f* does not take into account the sequence in which the trades take place; it does not consider equity drawdown.

These issues lead to the very limited use of the optimal *f* strategy in the trading community. This is the key: How much should you have invested in the game if you had had a limit on your maximum loss? It could be in absolute value (in dollars) or relative value (in percentage). If your limit is higher than $7,500 — say, $10,000 — nothing has to change, and optimal *f* is the solution. However, if your limit on your maximum loss during the game were, say, $5,000, then you could have only two contracts instead of three. The same is true if we assume that the limit on your acceptable maximum drawdown is 5%. That means that for your preference in this game, the optimal percent of the capital to invest would be 20%.

This fraction is what we call secure *f*. Every trader uses some value of secure *f* because every trader has some sensitivity to drawdown.

SECURE F

To formulate the problem solved by secure *f*, we add a constraint into the calculation of optimal *f*. The constraint may reflect the acceptable maximum drawdown (and/or other characteristics). This is a more conservative strategy that has the benefit of finding the percent of equity invested in every trade that would have yielded the highest possible return subject to the acceptable maximum drawdown.

Let us reformulate the problem of finding optimal *f* by adding the drawdown constraint:

TWR(f) —> max

subject to
Maximum drawdown(f) is less than or equal to acceptable maximum drawdown set by trader

The solution that maximizes TWR(f) is the secure *f*. The formulation of the problem that includes drawdown can be seen in Figure 2.

This formulation of the problem is such that its solution will maximize TWR and guarantee that the drawdown when running the system on past data does not exceed the amount defined by the trader — value *D*. This value is referred to as *acceptable maximum drawdown*. (This could be a trade or equity drawdown or other risk measure, or several risk measures at the same time. There could be a constraint that includes a measure of volatility. Other constraints can be taken into account in the same way as shown in Figure 2 just by adding more constraints.) Figure 2 has the prices as an additional input necessary for calculations.

If the acceptable maximum drawdown is smaller than the maximum drawdown during the period being considered, the secure *f* value will be smaller than the optimal *f* value and the secure *f* strategy will yield more conservative returns that will satisfy the limitations on the drawdown.

The equity curve for secure *f* will also have less variability. If the acceptable maximum drawdown is equal to or greater than the maximum drawdown during the period being considered, the secure *f* value will be equal to the optimal *f* value and the secure *f* strategy will yield the same results as the optimal *f* strategy. Figure 3 shows a graph of the TWR and maximum drawdown versus *f* value, and Figure 4 is a comparison table for optimal *f* and secure *f*.

COMPARISON TABLE

f	Contracts	TWR	MaxDD
0	0	100	0
5	0	104.74	0
10	1	108.9	2500
15	1	112.41	2500
20	2	115.2	5000
25	2	117.19	5000
30	3	118.3	7500
33	3	118.52	7500
35	3	118.46	7500
40	4	117.6	10000
45	4	115.64	10000
50	5	112.5	12500
55	5	108.11	12500
60	6	102.4	15000
65	6	95.29	15000
70	7	86.7	17500
75	7	76.56	17500
80	8	64.8	20000
85	8	51.34	20000
90	9	36.1	22500
95	9	19.01	22500

FIGURE 4: Increasing f values for percentage of capital add aditional contracts, but the terminal wealth relative is maximum at 118.52.

STRATEGY COMPARISON TABLE

Characteristics	Optimal f	Secure f
Max. # of contracts traded	75	4
Net profit % increase	310%	56%
Max. drawdown % increase	3962.50%	112.50%
Net profit/maximum Drawdown ratio	1.14 :1	8.27 : 1
Average trade (in $)	3,008.15	1,146.74
Standard deviation of Average trade (in $)	48,976	5,296
RINA index	13.92	34.32
Maximum drawdown (in %)	65.8	24.4

FIGURE 5: The simple breakout system that trades the mark buys on a 20-day price breakout and exits the position on a 10-day price reversal breakout. Using optimal f, the maximum number of contracts is 75 and the maximum drawdown is 65.8%. Using secure f and setting the maximum drawdown to $7,000, the maximum number of contracts is 4.

ALGORITHM

Let f^s be the value of secure *f*, D the acceptable maximum drawdown, TWR (*f*, *D*) the terminal wealth relative value for given values of *f* and *D*; delta is the desired accuracy for the secure *f* calculation. Below is a simplified form of the algorithm for the calculation of secure *f*.

Step 1 Calculate optimal *f*
Step 2 Set *f* = optimal *f*

If the acceptable maximum drawdown is greater than or equal to the historical maximum drawdown, then stop; otherwise, go to step 3.

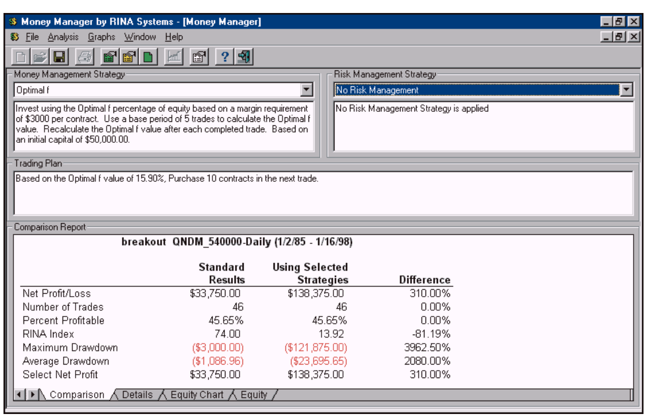


FIGURE 6: PERFORMANCE STATISTICS. The DM breakout system performance statistics using optimal f can be found here. The first column is a standard test trading one contract. The second column applies optimal f over the last five trades. The third column presents the difference between the two strategies.

MONEY MANAGER (RINA SYSTEMS)

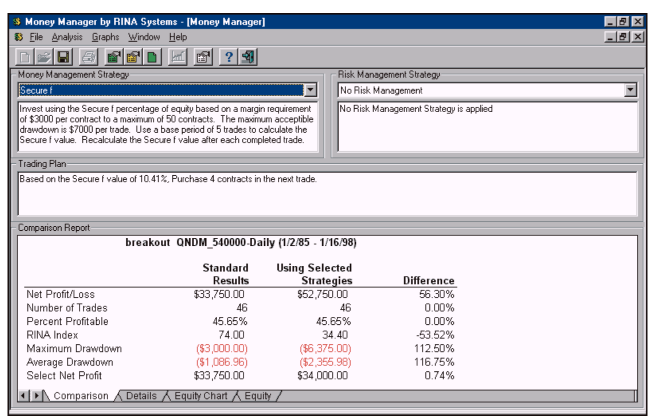


FIGURE 7: PERFORMANCE STATISTICS. The DM breakout system performance statistics using secure f are in this table. The column descriptions are the same as Figure 6.

MONEY MANAGER (RINA SYSTEMS)

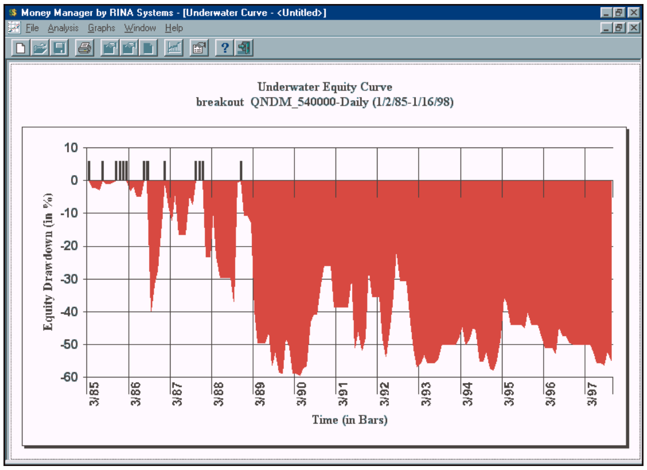


FIGURE 8: UNDERWATER EQUITY CURVE. Using optimal f, this chart shows the percent of drawdown as of the end of each month as measured from the previous equity peak and reflects the maximum possible equity retracement in percent at each point.

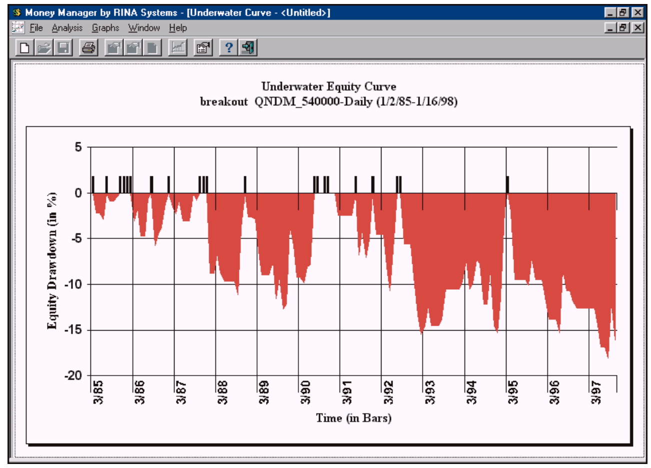


FIGURE 9: UNDERWATER EQUITY CURVE. Using secure f, this chart shows the percent of drawdown as of the end of each month as measured from the previous equity peak and reflects the maximum possible equity retracement in percent at each point.

Step 3 f = f - delta

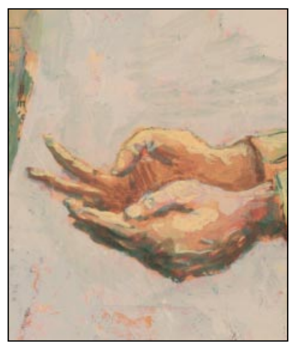
If f > 0, then

- Calculate MDD(f) - the maximum drawdown for the *f* portion of the capital to be invested in every trade using the information about trades and prices. If MDD(f) < D, then calculate TWR(f, D) and store the values of *f* and TWR(f, D).
- Return to the beginning of step 3.

If f < or = 0, then

- Find the value of *f* such that corresponds to the maximum of all TWR(f, D) stored. This value is the secure *f*, namely f^s.
- Stop.

The same logic could be applied to find the secure *f* for constraints on other than maximum drawdown.



APPLICATION AND COMPARISON

For comparison purposes, consider a simple breakout system that trades the German mark. The system buys on a 20-day price breakout and exits the position on a 10-day price reversal breakout. The TradeStation code for this breakout system is listed below:

Breakout system

```
Input: BLen(20), XLen(10);
IF CurrentBar > 1 and Close > Highest(High,BLen)[1] Then Buy on Close;
IF CurrentBar > 1 and Close < Lowest(Low,XLen)[1] Then ExitLong;
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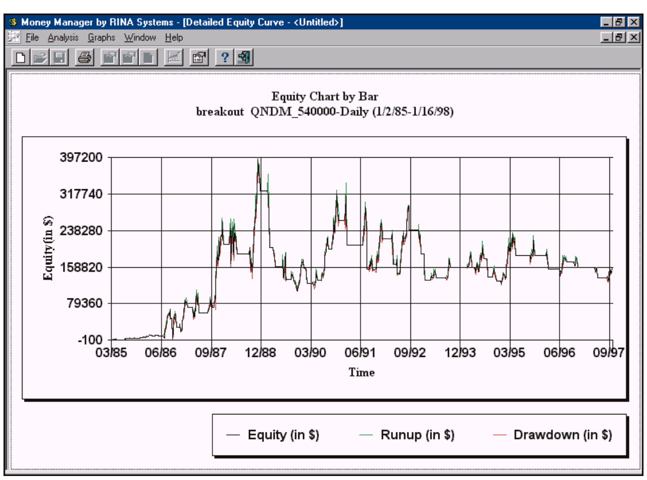

FIGURE 10: EQUITY CURVE. Here is the equity curve using optimal f. The equity growth, which is very erratic, peaks in 1998.

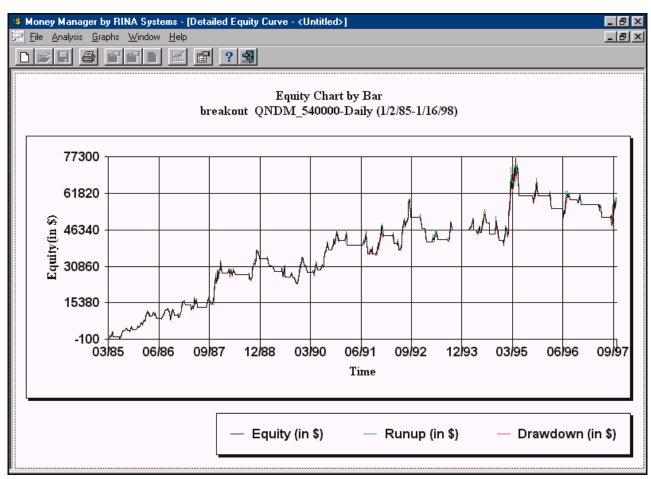

FIGURE 11: EQUITY CURVES. Here are the equity curves by bar for secure f. Note the steady rise using the DM breakout system.

Both optimal *f* and secure *f* strategies increased the net profit but at a cost to the maximum drawdown. The increase of maximum drawdown relative to net profit clearly indicates the dramatic differences between these two strategies. Although the optimal *f* strategy generated a much larger net profit, the net profit/maximum drawdown ratio for secure *f* is more than seven times higher than the same ratio for optimal *f*. The strategy comparison table in Figure 5 outlines the differences between the strategies.

During the 12-year test period (1985-97), the optimal *f* strategy would have attempted to trade 75 German mark contracts in a single trade. The secure *f* strategy, on the other hand, would have traded a maximum of four German mark contracts at a single time.

The breakout system performance using optimal *f* and secure *f* can be seen in Figures 6 and 7. Figures 8 and 9 illustrate the corresponding underwater equity curves for both optimal *f* and secure *f*. Figure 9 shows the percent of drawdown as of the end of each month as measured from the previous equity peak and reflects the maximum possible equity retracement in percent at each point. These figures show the big difference in the equity drawdowns for optimal *f* and secure *f*. Finally, Figures 10 and 11 depict the equity curves by bar for optimal *f* and secure *f* correspondingly.

CONCLUSIONS

Secure *f* money management strategy offers traders the ability to maximize the return subject to the level of risk they are willing to assume. Secure *f* can be a conservative or aggressive strategy, depending on the level of acceptable maximum drawdown selected by the trader. This level can be set by each individual trader to match the trader's preferences. The secure *f* strategy can be applied to both mechanical and nonmechanical trading and to increase profitability in any market.

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RINA Systems is the developer of Money Manager, Performance Summary Plus, Portfolio Evaluator, 3D SmartView and Dynamic Zones software for evaluating and improving trading systems. RINA Systems is also a codeveloper of Portfolio Maximizer.

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RELATED READING

Vince, Ralph [1990]. *Portfolio Management Formulas*, John Wiley & Sons.

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