A review of trade managements

part I - Single position trades

Important notice

This document contains a heavy dose of mathematics. In case of allergy take your pills ;-)

Statement of the problem

Let's consider a system where a trade is made of a single position. The position is opened with a stop loss. Let's call it *SL*. In case the trade is a winner we get a profit *TP*. *TP* is not necessarily known beforehand. The SL may also be unknown in advance and the trade exited based on price action instead of a predefined price value. But let's keep it simple and let's assume it is fixed (because it will converge towards its average).

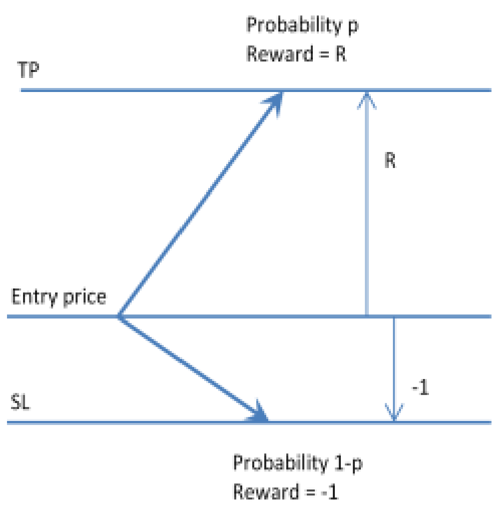
Can we improve this system by only managing the open position?

Normalization of the Reward for Risk ratio

Let consider the *TP* as R times the *SL* ($TP = R \times SL$). Now we can say that we risk one time the *SL* to win *R* times the value of the *SL*. We can normalize the *SL* to 1 time the risk. $SL = 1$. Not 1 pip but 1 unit of risk. We now take profit at R times the risk. $TP = R$. Not *R* pips but *R* unit of risk. We have a R: 1 reward for risk ratio. The spread is considered as a cost of opening a position so we won't have it in the equations.

Probability

Let's consider a "*set and forget*" trade. We will use it as the reference trade. The position is opened with a *SL* and exited either at some *TP* defined by the exit criteria of the system (win) or when our stop is hit (loss). We consider the event "The price reaches *TP* before *SL*". The probability of this event is the win/loss ratio of our system. It is between 0 (always losing) and 1 (always winning). Let's call is p. We make no more assumption about the value of p. It is an unknown in our equations.



Either we win or we lose, the probability of losing is $1 - p$ (the complement of winning). The figure on the left side represents the path the price may take from the entry to one of the two exits. Note the actual path of the price is not a straight line, this is just a representation. The up-going arrow means the price goes from the entry to the *TP* without going to the *SL*. Yet it may miss it by half a pip. Same thing for the down-going arrow. It means the price goes to the *SL* without reaching the *TP*. Again it may miss it by half a pip...

Expectancy

Simply stated the mathematical expectation, or expectancy, is the average of the winners and the losers weighted by their respective probability. It is the average revenue per trade. We want it as big as possible. That's what we want to optimize. Of course it needs be positive to be profitable. Now on, let's see a loss as a negative reward. To know the expectancy, multiply the reward by the probability of its occurrence. Sum them all. Don't forget any.

Here it is easy. There are only two outcomes. Either we win R or we lose 1. Oops sorry... or we win minus one! Our reference trade makes R with a probability p and make -1 with a probability $1 - p$. The expectation E_0 of "*set and forget*" is

$$E_0 = Rp + -1.(1-p) = Rp - (1-p) = Rp + p - 1 = (R+1)p - 1$$

It's important to realize that the expectancy is increased either when the probability p increases or when R increases. Because p is a probability it can never be higher than 1. On the other hand, at least theoretically, R is unbounded. It is then natural to seek increasing R rather than p.

In the sequel, we do not consider E_0 is positive. It is just what it is. We accept the system may be a loser. We also assume nothing about the probabilities. They depend on the strategy and the market behavior during the trade. We assume no specific probability distribution especially not the Gaussian distribution.

Let's see how the different trade managements modify the expectancy of the system.

Partial profit after X pips, SL doesn't move

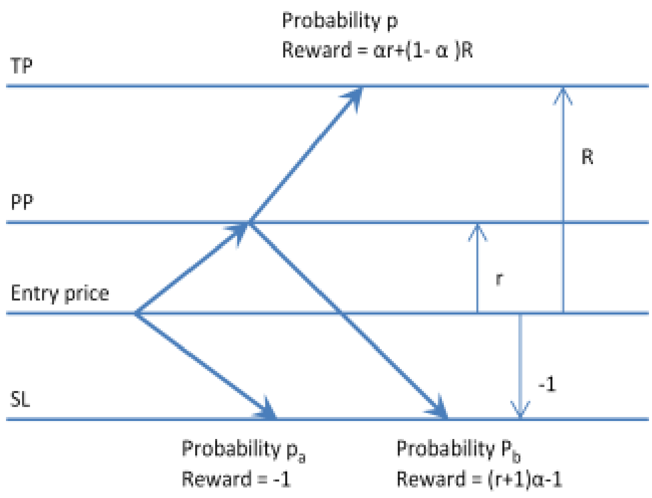
Let's consider a trade management consisting in taking a partial profit when the position is at some profit and let the stop where it is to let the price some room to move. The idea behind is to secure some profit in case of a reversal while "letting the profit run" if the price continues in the intended direction. We ask us the question:

What is the optimal price where to partially close and what is the optimal percentage of the trade to close?

What is the expectancy of the partial TP trade management?

This one is more complex. We need first to distinguish all the possible scenarios and associate them their probability.

We consider a new price level where we take partial profit: *PP*. When the price reaches *PP* the first time, we close a portion α of the position. α is between 0 (we close nothing at all) and 1 (we close the whole position).



Because we consider locking profits, *PP* is between the entry price and *TP*. The reward we get at this point is r multiplied by the portion α of the position size (small r stands for small reward). r is between 0 (we close at break-even) and R (we close at the *TP* price). Let's enumerate all the scenarios.

Case A: Price goes directly to *SL*. Reward -1.

Case B: Price reaches *PP* then reverses to *SL*. Reward is αr from the partial close plus $(1-\alpha)$, the complement of the partial close, multiplied by the loss of *SL* which is -1 (a loss is a negative reward and *SL* is normalized to 1). Reward is $\alpha r - (1-\alpha) = (r+1)\alpha - 1$.

Case C: Price goes to *TP*. It can only do so by going to *PP* first. The reward is the sum of the partial profit and the remainder of the position. Reward is $\alpha r + (1-\alpha)R$.

We notice that the case C is the only one where the price goes to *TP*. In this case, price goes to *TP* before going to the *SL*. We know the probability of this event. It is p.

We don't know the probabilities p_a and p_b of the cases A and B. But we know these are distinct cases and in both cases price goes to *SL* before *TP*. So we know their sum is the complement of p. So we know $p_a + p_b = 1-p$.

We can now calculate the expectancy of the partial profit trade management.

$$E_{partial} = [\alpha r + (1-\alpha)R]p + [(r+1)\alpha - 1]p_b - p_a$$

Let's expand the second part

$$E_{partial} = (\alpha r + (1-\alpha)R)p + \alpha(r+1)\, p_b - p_b - p_a$$

We know $p_a + p_b = 1-p$. We have the term $-p_b - p_a$ which is $-(p_a + p_b)$ which is $-(1-p)$, which is $p-1$. So

$$E_{partial} = [\alpha r + (1-\alpha)R]p + \alpha(r+1)\, p_b + p - 1$$

Great! So what?

We now have an ugly equation made of things we don't know. How can this help? We are trying to improve the reference trade "*set and forget*". We know its expectancy is E_0. The improvement of the expectancy of the system is $\Delta = E_{partial} - E_0$.

$$\Delta = E_{partial} - E_0 = [(\alpha r + (1-\alpha)R)p + \alpha(r+1)\, p_b + p - 1] - [(R+1)p - 1]$$

- If Δ is positive $E_{partial}$ is greater than E_0 and the system is improved.
- If Δ is negative we made things worse.
- If Δ is 0 we changed nothing at all.

Let's calculate Δ.

$$\Delta = [(\alpha r + (1-\alpha)R)p + \alpha(r+1)\, p_b + p - 1] - [(R+1)p - 1]$$
$$\Delta = (\alpha r + (1-\alpha)R)p + \alpha(r+1)\, p_b + p - 1 - (R+1)p + 1$$

$$\Delta = (\alpha r + (1-\alpha)R)p + \alpha(r+1)\, p_b + p - (R+1)p$$

Let's simplify

$$\Delta = \big(\alpha r + (1-\alpha)R + 1 - (R+1)\big)p + \alpha(r+1)\, p_b$$

$$\Delta = (\alpha r - \alpha R)p + \alpha(r+1)\, p_b$$

$$\Delta = \alpha(r-R)p + \alpha(r+1)\, p_b$$

$$\Delta = \alpha[(r-R)p + (r+1)\, p_b]$$

What do we know? We know that $0 \le \alpha \le 1$, $0 \le p \le 1$, $0 \le p_b \le 1$ and $0 \le r \le R$

r is smaller than R, therefore $r - R \leq 0$ and so is $\alpha(r - R)p$. Because this term is negative we must optimize it as near of zero as possible to increase Δ. We can make it 0 either by setting α to 0 or by setting $r = R$ or both. Setting α to 0 also makes the second term null and Δ becomes 0. No improvement. Obvious, it means closing 0% of the position: it is the reference trade "*set and forget*".

The second term is positive. We want it as big as possible. We cannot control p_b. So we must make r as big as possible. But r is limited to R, so the optimal value for r is R.

Result

Setting α to zero means closing 0% of the position. Setting $r = R$ means partially closing at the same time as we close the rest! **The optimal solution to the problem is to not close partially without trailing the stop.**

The partial closing of the position cannot turn a losing system into a winner. It can only reduce the profitability of any winning system. It may, but not necessarily, turn a winning system into a losing one.

Let's put some figures in the equation for Δ. How many times have you read the sentence below in the forum?

"I close half of my position when the profit is equal to my SL. So I let the profit run, worse case I'm break-even"

So this trader chose $\alpha = 1/2$, one half of the position size and $r = 1$, which is the value of our normalized *SL*. Let's see how he "improved" his system:

$$\Delta = \alpha[(r - R)p + (r + 1)\, p_b]$$

$$\Delta = \frac{1}{2}[(1 - R)p + (1 + 1)\, p_b]$$

$$\Delta = \frac{(1 - R)p}{2} + \ p_b$$

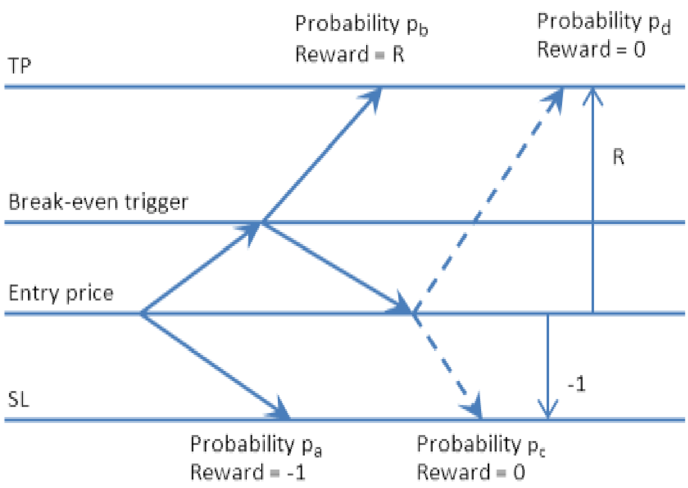
All the idea of the tenet *"let the profit run"* is to have R as big as possible. R cannot be less than 1 since in this case 1 is the value of r. Otherwise there is not partial closing. Therefore $1 - R$ is negative.

All the idea of a trading system is to have p as near of 1 as possible. Here we have a term in $-\frac{Rp}{2}$ against Δ. The better the system (a big R, a big p and therefore a small p_b) the worse Δ becomes negative!

The term p_b won't help to increase Δ. It is part of the probability of losing ($p_a + \ p_b$). To increase Δ it needs be big, to have a profitable system we want it small!

Trailing SL to break-even after X pips

Let's consider a trade management consisting of trailing the stop to break-even when the position is in profit. This way we can no more lose, right? How does it influence the expectancy?



To help enumerating the scenarios, we represent in dash lines the path the price would have followed after reaching the breakeven point. We get four possibilities.

Case A: Price goes directly to *SL*. Reward -1.

Case B: Price goes directly to *TP*. Reward R.

Case C: Price reaches the trigger level then reverses to *SL*. Reward 0.

Case D: Price reaches the trigger level, reverses to *BE*, then goes to *TP*. Reward 0.

Here we have a system where we know none of the variables. Yet we can express its expectancy E_{BE}.

$$E_{BE} = Rp_b - p_a$$

Let's calculate the value of *Δ*

$$\Delta = E_{BE} - E_0 = [Rp_b - p_a] - [(R+1)p - 1]$$

$$\Delta = Rp_b - p_a - Rp - p + 1$$

Let's factor in R and re-order the terms

$$\Delta = (1-p) - p_a + R(p_b - p)$$

We don't know the probabilities p_a and p_b yet we can interpret the value of *Δ*. We notice the term $(1-p)$ which is the probability of losing. The probability p_a is the probability of losing before the trigger point is reached. The term $(1-p) - p_a$ is thus the probability of losing after the trigger point is reached. Because it is a probability its value is between 0 and 1. It makes sense that this term increases *Δ* since "a winner turning loser" is exactly the case we want to avoid by trailing the stop. The two probabilities p and p_a are inversely linked. We can easily see that when one increases the other one decreases (the more you win the less you lose and conversely). To the extreme, if p goes towards 1 (a very high win/loss ratio), p_a goes towards 0 and the term $(1-p) - p_a$ decreases towards 0. If p is near 0 (pathologic loser system), p_a increases to 1. Again the term $(1-p) - p_a$ decreases towards 0. If the probability p is 0.5, $1-p$ is also 0.5 and because p_a>0 the term $(1-p) - p_a$ will be less than 0.5. This value will certainly never be really high.

Let's have a look at the second term $R(p_b - p)$. The term p_b is the probability of having the price reaching *TP* before *SL* but after we have been taken out for BE. That is killing a winner by choking the trade. The probability p is the sum of p_b and p_d both positive. Clearly $(p_b - p) = -p_d$ is negative. The bigger R is the worse *Δ* is impacted. Relying on a small *R* and high p doesn't help because it is still negative and we saw in the previous paragraph that the first term is usually too small to compensate, especially if p is high.

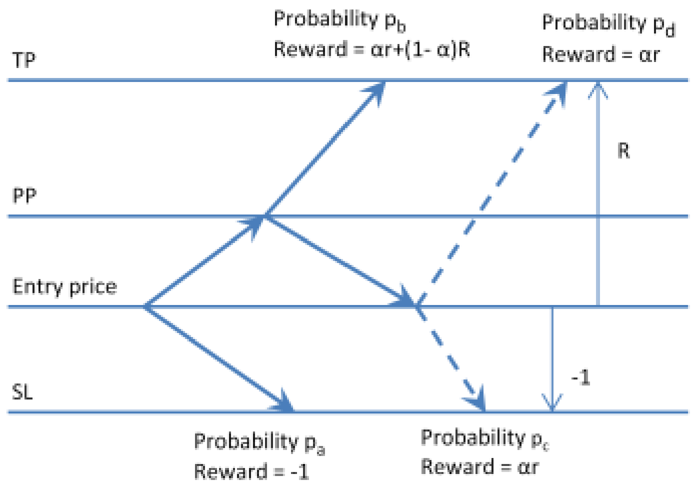
One can also realize that if $(1-p) - p_a$ is high it means that the trigger price level is a high probability reversal point. It should better be the *TP* level! This hints us that the optimal position of the trigger level is the *TP* level itself and that we shall not trailing the SL to BE at all.

Partial TP plus trailing the SL to BE

So far, not so good… Let's have a look at the method consisting is taking a partial profit and trailing the SL to BE at the same time. The idea behind it to avoid a winner turning loser and in the case we kill a winner, at least we still get something from this trade.

We consider again the price level *PP* where we take partial profit and we let α be the portion of the position that we close. We remember that *PP* is between the entry price and *TP* and α is between 0 and 1. The level *PP* is associated to the reward r multiplied by α.

Once again let's draw the schema to help us defining the expectancy of this management.



There are four possible cases:

Case A: Price goes directly to *SL*. Reward -1.

Case B: Price goes directly to *TP* but it has to cross *PP* first. Reward $\alpha r+(1-\alpha)R$.

Case C: The trade is stopped out at BE point while it would have been a loser. Reward αr.

Case D: The trade is stopped out at BE point while it would have been a winner. Reward αr.

The expectancy is:

$$E_{partial+BE}=[\alpha r+(1-\alpha)R]p_b+\alpha r(p_c+p_d)-p_a$$

$$E_{partial+BE}=(1-\alpha)Rp_b+\alpha r(p_b+p_c+p_d)-p_a$$

The sum $p_b+p_c+p_d$ is the complement of p_a and can be rewritten $1-p_a$

$$E_{partial+BE}=(1-\alpha)Rp_b+\alpha r(1-p_a)-p_a$$

$$E_{partial+BE}=(1-\alpha)Rp_b+\alpha r-(\alpha r+1)p_a$$

Let's find Δ

$$\Delta=E_{partial+BE}-E_0=[(1-\alpha)Rp_b+\alpha r-(\alpha r+1)p_a]-[(R+1)p-1]$$

$$\Delta=(1-\alpha)Rp_b+\alpha r+1-(\alpha r+1)p_a-(R+1)p$$

$$\Delta=(1-\alpha)Rp_b-(R+1)p+(\alpha r+1)(1-p_a)$$

$1-p_a$ is the probability of reaching *PP* before the stop. It is positive and obviously positively influences Δ as seen in the term $(\alpha r+1)(1-p_a)$. It is maximized for the extreme values $\alpha=1$ and $r=R$. This goes against the idea of partially closing. The term $-(R+1)p$ is negative. It is no surprise that the bigger the reward for risk ratio is the worse closing early impacts the profit since the dollar value of the remaining pips is now smaller. $(1-\alpha)Rp_b$ is positive (because $\alpha\leq 1$) it is maximized for $\alpha=0$, again suggesting to not closing partially at all. It is also maximized for the bigger values of *R* but as we just saw it is "competing" with the term in $-(R+1)p$ but because p is greater than p_b (p is the sum of p_b and p_d) their sum is always negative.

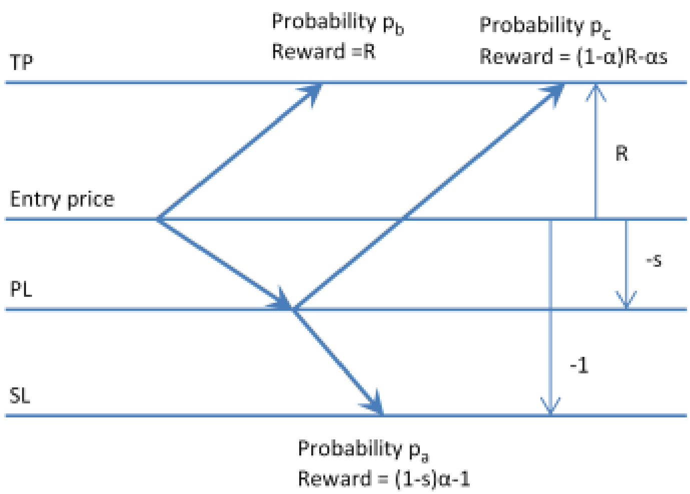
Scaling out of a losing position

We couldn't find a solution to improve the profit. Let's try to minimize the loss. If the position is in the negative territory, let's close a portion of it so if it reaches the SL the loss is smaller.

We now consider a new price level *PL* where we take a partial loss. When the price reaches *PL* the first time, we close a portion α of the position. As usual α is between 0 (we close nothing at all) and 1 (we close the whole position). The distance between the entry price and the *PL* level is s (for small stop).

Let's first see how much we lose when the *SL* is hit. To reach *SL* the price must go through *PL*. At *PL* the loss is $-s$ then the position size is $1-\alpha$. The distance between *PL* and *SL* is $1-s$. The second part of the loss is $-(1-\alpha)(1-s)$. The total loss at *SL* is $-s-(1-\alpha)(1-s)$ that we can simplify as $(1-s)\alpha-1$.

Let's see how much we make as profit if the *TP* level is reached after the *PL* was touched. When the *PL* is touched we realize a (negative) gain of $-\alpha s$. After the position size is $(1-\alpha)$ and the profit is made from the entry price to *TP* which distance is *R*. The net profit is $(1-\alpha)R-\alpha s$.



We can now sketch the different scenarios.

Case A: We take the lightened loss. Reward $(1-s)\alpha-1$.

Case B: Price goes directly to *TP* with the full position. Reward R.

Case C: Price reaches *TP* after it reached *PL* first. Reward $(1-\alpha)R-\alpha s$

The expectancy is $E_{PL}=[(1-s)\alpha-1]p_a+Rp_b+[(1-\alpha)R-\alpha s]p_c$

The expression for Δ becomes

$$\Delta = E_{PL}-E_0=[(1-s)\alpha-1]p_a+Rp_b+[(1-\alpha)R-\alpha s]p_c-[(R+1)p-1]$$

We notice that $p=p_b+p_c$.

$$\Delta = [(1-s)\alpha-1]p_a+Rp_b+[(1-\alpha)R-\alpha s]p_c-(R+1)(p_b+p_c)+1$$

$$\Delta = [(1-s)\alpha-1]p_a+Rp_b+(1-\alpha)Rp_c-\alpha sp_c-(R+1)p_b-(R+1)p_c+1$$

$$\Delta = [(1-s)\alpha-1]p_a-p_b-[\alpha(R+s)+1]p_c+1$$

We know that $p_a+p_b+p_c=1$.

$$\Delta = [(1-s)\alpha-1]p_a-p_b-[\alpha(R+s)+1]p_c+(p_a+p_b+p_c)$$

$$\Delta = \alpha[(1-s)p_a-(R+s)p_c]$$

It's quite logical that the term $\alpha(1-s)p_a$ improves Δ since p_a is the probability of losing. The sooner and the more we close this future loser the better... but we can never know for sure that it will be a loser because of p_c. The value is maximized for $\alpha = 1$ and $s = 0$ meaning not taking the trade at all! Obviously this extremely conservative approach isn't very rewarding but is the best to use if the system is a loser. As soon as the system is a winner the term $-\alpha(R+s)p_c$ degrades Δ. It is maximized with $\alpha = 0$ meaning not scaling out. If we imagine that p_c can be 0, it would mean that if the price reaches this level it can no more return to *TP*. *PL* shall be *SL*: where we close everything!

Conclusion of part I

We proved that taking partial profit only destroys the potential of the winners. They may no longer cover the losses. Trailing the stop to BE increases the risk of being unduly stopped out and it costs more than it saves because some risk was taken for no reward. If the SL is at a given place it is for a reason and as long as it isn't hit the trade is still a potential winner and that if this isn't true the SL is not at the right place.

part II - Multi-positions trades

Now we consider the trade is made of several positions. **The subsequent positions are not taken based on a new signal**. We only try to exploit one single signal to its maximum potential.

We saw in the first part that we cannot improve the expectancy of a strategy by simply fiddling with the position once it is open. We search a method to increase the reward for risk ratio R in order to increase the expectancy. Since we cannot decrease the risk can we increase the reward?

If we do not trail the stop or reduce the risk we can no more add to a position without increasing the risk. If we want to add to the position in order to increase R we have to sacrifice a little of the expectancy of the base strategy or accept an increase in the risk. But the net effect must be an increase of R.

Adding to the position after a few positive pips

If we open a new position when the price has already progressed toward the target, the potential profit of this second position is less than the one of the first position. The more the worse.

If the SL of the second position is bigger than the one of the first position we more than double the risk while we less than double the reward. R decreases.

If the SL of the second trade is smaller than the one of the first position we increase the probability of being stop out on this second trade with the effect of reducing the final profit.

We need a SL large enough to not be stopped out frequently and at the same time a small SL to increase the R:R.

(I'm still looking for a good solution...)

Forward gridding (anti-martingale)

The forward gridding consists in adding a new position at evenly spaced price levels between the entry price and the TP. If the trade is a straight winner the profit is 1 grid step for the last position, 2 steps for the one before, etc. For a N step grid with steps of size s, the profit is $s + 2s + 3s + \cdots + Ns = \sum_{i=1}^{N} s.i = s.\frac{N(N+1)}{2}$. The price at $s.N$ is the TP therefore it is R when the first SL is normalized to 1. This looks promising because we can expect a maximal reward of $\frac{R(N+1)}{2} = \frac{R^2+sR}{2s}$ which is quadratic in the number of steps. But each step brings a risk ρ on top of the initial risk of the first position because these positions can be stopped out for a loss. The value of ρ depends on the stop used for the new positions, their size and the volatility of the market during the trade (probability of being stopped). It can only be known statistically.

If we don't reopen a triggered level, the risk is $1 + \rho(\mathrm{N} - 1)$. We get a risk which is linear in the number of steps. The reward for risk ratio R_{grid} is a quadratic function divided by a linear function of the number N of steps. It is a linear function in N like the original R but we have the $\frac{1}{2}$ factor. (Is the grid just a hidden over-leverage?)

$$R_{grid} = \frac{sN(N+1)}{2[1 + \rho(\mathrm{N} - 1)]}$$

Re-opening the stopped levels when they are reached again increases the loss. The number of times a level can be re-opened is unbounded (at least in theory). This brings the potential accumulated losses to $+\infty$. The realized losses can be greater than the profit when the TP level is reached. In this case the winning scenario is a loss and the R:R becomes negative! Of course the trade will be stopped for a loss when the potential reward can no longer exceed the accumulated loss, avoiding bankruptcy.

Adding to the position after a few negative pips

In this scenario we are not allowed to set the SL of the second position beyond the SL of the original position because the SL of the first position is the point where the trade is declared a loser. We don't want to add on a loser in "hope mode" we want to increase the expectancy.

This second position has a bigger potential profit (TP is farther) and the potential loss is smaller (SL is nearer). If the second position is triggered the value of R is increased. The maximum is for a position opened right before the SL where the potential profit is $\approx R+1$. Of course the probability of being triggered while still winning the trade is certainly very small. In order to increase the probability of being triggered we have to open the second trade earlier. If the second trade is opened as soon as the first one is negative and we keep the SL, we simply double the risk to double the profit the reward/risk ratio remains the same. The SL must be smaller. It shall not be too tight to avoid a systematic loss.

If the probability of a little pullback after the entry is small, that is we expect the price to go directly to the target, we can open two positions at the entry price, the second one with a smaller SL, say half the SL. The risk is increased by 50% while the maximal reward is doubled. R is multiplied by $\frac{2}{1.5}$, or 33% increase, in the good case. In the bad case R is reduced only of 0.5. This is typical of a "pin bar with the trend" entry.

If this probability of a little pullback after the entry is high we wait the pullback to happen and open the second position with the SL at the same place as the first one. Say we set a limit order half way between the first entry and the SL. The risk is increased by 50% while the reward is more than doubled and R increases to $\frac{R+(R+0.5)}{1.5}$. This is typical of a "bearish/bullish outside bar" entry.