Chapter 9

Manage Your Losses

- *What will you learn here:* Whether you need a stop-loss policy; what are the trade-offs and how do they depend on your performance parameters?
- *Why do you need it:* Because, in the long run, your survival as a fund or portfolio manager *will* depend on setting an effective stop-loss policy. Hence, it is extremely important.
- *When will you need this:* You will set the policy very rarely – usually, only once in the lifetime of a fund. For a portfolio manager, the policy will be binding much less than once a year.

To many readers of this book, loss management is the only form of risk management that matters. "Factors", "alpha", "optimization", "risk limits": these are all modeling constructs; PnL, on the other side, is tangible. A large loss is a threat to the survival of a fund. A simple evasive strategy is to fly from the threat.

In an investment strategy, this means liquidating stock holdings into cash. This is often referred to as a "stop-loss" policy. When some threshold is reached, a partial or total liquidation occurs. The rule does not require data or complex models; it is simple; it resonates with human behavior; and it seems *necessary*. Yet, there is no agreement on stop-loss policies. The first section of this chapter is devoted to exploring the arguments in favor and against these policies. The second section connects the design parameters of the policy to the investor's own characteristics and goals. Finally, we look at variants of the rule.

9.1 How Stop-Loss Works

A Portfolio Manager is hired by a hedge fund. The first thing she agrees upon is her budget: how much capital, or how much dollar volatility, she can deploy. The second thing is the loss policy. After the onion of "recommendations" and "portfolio reviews" is peeled, what is left is an estimate of the maximum tolerable loss, after which the PM's portfolio is liquidated. The PM is also usually liquidated, but sometimes is given a second chance. In its simplest form, a stop-loss policy is just this: how much you can lose before it's over. This is hiding many details, however. The starting date from which losses are estimated, for starters. The most common choice is the high watermark of the strategy; less frequently, losses are measured within a calendar year, and over a 12-month rolling period; throughout the chapter, I focus only on the losses from the high watermark. Besides the single-threshold stop-loss rule, there is a two-threshold variant that is also popular. When the first threshold loss is met, the portfolio is reduced in size; a common choice is 50%. Then if the strategy keeps losing money and reaches a second threshold, the portfolio is finally liquidated. The two-threshold variant is not radically different from the single-threshold one. A prudent portfolio manager would reduce capital as she approaches the liquidation threshold. In an early, important analysis of stop-loss [Grossman and Zhou, 1993] show that, if the PM has the objective to maximize the strategy's expected rate of return while never hitting the loss threshold, then it is optimal to hold a GMV that is at its upper bound on a high watermark, but it is proportionally reduced as the distance to the stop-loss threshold is reduced, and is fully liquidated to cash when the threshold is reached.[1] The rationale for the more complex variant is that it enforces this discipline.

Stop-loss procedures can be further classified into two types:

- **Stop-and-Shutdown**. When a portfolio reaches the final loss threshold, it is definitely liquidated and the strategy is shut down permanently.
- **Stop-and-Restart**. When a portfolio reaches the final loss threshold, it is liquidated but the positions are still updated and the pro forma performance of the strategy is still monitored. When it recovers (i.e., has a return exceeding a certain hurdle), the portfolio is capitalized again and starts trading.

As always, there is not a hard separation between these two procedures. Within the same firm, a PM with a long track record is stopped and then restarted, while a new one is not given the benefit of the doubt.

9.2 Why a Stop-Loss Policy?

We review the rationales behind this rule and its drawbacks.

These are the arguments in favor.

- **There is the stop-loss that you have, and the one you don't know you have**. The difference between a firm with a stop-loss policy and one without is that you find out about the stop-loss policy of the latter when it is too late. But rest assured that they *always* do have one. It may be discretionary; it may be PM-specific; it may be truly inscrutable and non-replicable, but it exists. What is at issue then is whether it should be transparent or not. My experience is that almost all PMs would be in favor of transparency, and almost all hedge fund managers would be against, even though they insist that they don't really have one and *this is good for you.* As a rule

[1] Two secondary observations: 1. the optimal GMV rule is not exactly proportional, but it is very well approximated by it; 2. since this is an idealized model, the threshold is actually never reached and capital is never set exactly to zero.

of wisdom, don't trust any hedge fund manager who tells you that something is good for you unless that hedge fund manager is your mother.[2] And because stop-loss rules exist, you may as well understand whether its parameters suit your investment profile or not, which is the subject of the remainder of the chapter.

- **Stop-loss rules are a partial hedge for the PM call option**. If a PM is paid for performance in full every year, without deferred compensation and any clawbacks,[3] then she holds a call option on the underlying value of her strategy. The strike price is higher than the initial value of the portfolio, because the PM must recover operating costs; the payoff is not the PnL of the portfolio but a percentage of it, with some kickers for high performance or high risk-adjusted performance. Since the value of the option increases with the volatility of the underlying asset, it is in the interest of the manager to run with the highest possible volatility, independently of her skill. The stop-loss is a constraint that limits the value of this option. If the PM has poor investing skill, her portfolio's PnL will get closer to a threshold. In order to still be able to trade she will reduce her volatility, a phenomenon that is intuitive, confirmed in practice and justified by some theory that we will discuss below. By reducing volatility, the value of the call option is reduced.
- **Stop-losses can be interpreted as a form of portfolio insurance**. Consider the case in which the PM buys full downside insurance in the form of an out-of-the-money put option on the portfolio value, with notional value equal to the maximum GMV limit. It can be shown that the option can be approximately replicated by a combination of the portfolio and cash that is close to the drawdown policy. There are differences between the "ideal" policy, the proportional policy, the put policy and the two-threshold policy,[4] and they are shown in Figure 9.1. The Grossman-Zhou proportional policy is the most aggressive: it starts reducing immediately. The

[2] Correction: except when your mother asks you to sign a contract. Then don't trust her.

[3] "Clawbacks" are conditions according to which a PM's deferred compensation is reduced if she loses money in a year.

[4] Let the portfolio have high watermark value S_0. Having a stop-loss at loss r is equivalent to holding the portfolio and purchasing a put with strike price $K = S_0(1 - r)$. At time t the portfolio has value S and the option has value $V(S)$; the put is equivalent

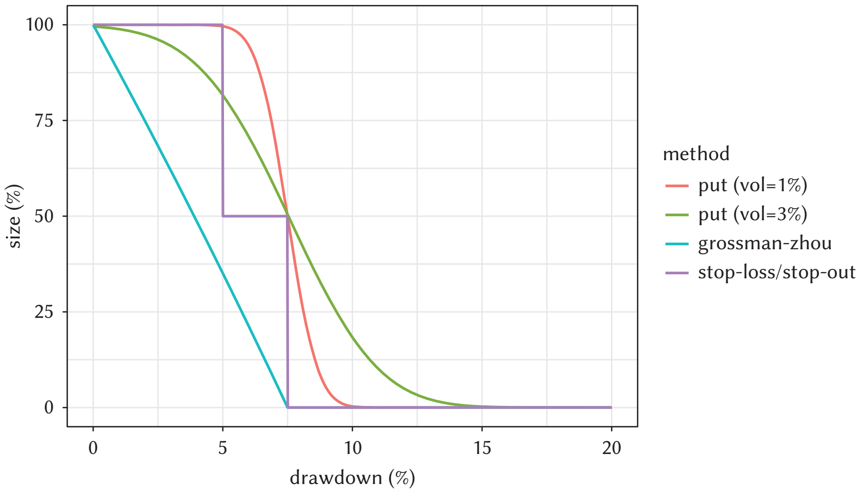

Figure 9.1 Deployed Capital as a function of drawdown for Grossman-Zhou optimal growth rule, portfolio insurance for two strategies with daily volatilities of 1% and 3%, and for a two-threshold policy, as adopted in many hedge funds.

portfolio insurance policy depends on the volatility of the underlying strategy. A more volatile strategy must reduce earlier, but can hold capital beyond the stop-loss, because greater volatility means that the strategy has greater optionality. A less volatile strategy is "stiffer": it reduces later but faster.[5] Finally, the two-threshold policy can be "tuned" to approximate any stop-loss curve.

In summary: provided that a strict limit to losses always exists, a GMV reduction policy that decreases as the distance from the max

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to a cash position and amount

$$\delta(S) = \frac{\partial V}{\partial S}(S)$$

Hence the effective portfolio size is $S + \delta(S)$. The policy for Grossman and Zhou is $f = S_0(1 - r/(S_0 - S))$.

[5] Sometimes you'll hear the expression that stop-loss policies have "negative gamma". This is a way of saying that the value of the embedded put option, as a function of the underlying, is a convex function: its second derivative with respect to the underlying is negative. This is actually true in the first part of portfolio reduction only, but the initial portfolio reduction is what occurs most often and therefore matters most.

loss decreases is both intuitive and justified by some quantitative models. What are the arguments against a stop-loss policy?

- **Transaction costs can be significant**. Executing the strategy requires reducing the Gross Market Value of the book independently from fundamental considerations (like an increase or reduction in investment opportunities). As an example, a PM has a turnover of 12/year, measured as the ratio of dollars traded in a year/GMV. He incurs losses and reduces GMV by 50% and grows it back 1 month later. The turnover is 11x (the eleven months during a normal regime) + 0.5x (the one month run at 50% GMV) + 1x (the de- and re-grossing). This is an increase of 5%, and a larger increase expressed as transaction costs, because the individual trades in a partial liquidation are much larger than routine trades. Stop-losses don't occur every year; however, the implementation cost of the policy, averaged over the years, is non-negligible and must be assessed (e.g., by simulation).
- **The opportunity costs can be large**. This is the most important objection to stop-losses. By cutting capital in a drawdown, we are less well-positioned to exploit the recovery phase. We are forgoing PnL. There are papers (mostly theoretical, and with little empirical basis) that show how, if certain assumptions hold, then stop-loss policies will make money for the PM. For example, if past positive PnL is a predictor of future positive PnL (and vice-versa), then you can imagine how the policy helps: if I am losing money and therefore will lose money, it is better to reduce now to avoid incurring future losses. However, these papers miss the point. Stop-loss exists to ensure survival of a firm, not to improve the performance of a strategy. There is a price to pay. We just need to make sure we are not overpaying, or at least that we understand the trade-off between survivability and the parameters of stop-loss.

9.3 The Costs and Benefits of Stop-Loss

A shallow stop-loss threshold reduces profitability; a large one is ineffective at managing risk. Is there a "Goldilocks" region in which stop-loss reduces risk without affecting performance? To explore this question, I resort to simulation. Consider PMs with a fixed annualized volatility and an annualized dollar volatility. I simulate PMs' returns with a range of Sharpe Ratios and a range of stop losses. For each PM and for every simulation I measure two important metrics:

- The ratio of the average annual PnL over the entire horizon to the strategy's dollar volatility *when the strategy is active*. I denote this ratio "efficiency". This is not the same as the realized Sharpe Ratio. If a PM is stopped at the end of year one, and we simulate a period of ten years, the realized volatility of years two to ten is zero, and the PnL is zero. This is misrepresenting the performance of the strategy, so we measure the average PnL of the entire ten years over the *allocated* volatility during the same interval;
- The ratio of stop-loss limit to allocated vol. This measure is natural. We often speak of a "two sigma" loss to mean that the dollar loss was equal to twice the dollar volatility allocated to a strategy.

To make the simulation more comprehensive, I consider two operating horizons: five and ten years; not many PMs operate in the same firm for ten years, but it is important to understand how the horizon affects the results. I consider two stop-loss policies: a single-threshold one (liquidate the strategy at $x\%$ loss) and a two-threshold one (cut capital in half when loss reaches $(x/2)\%$, and liquidate at $x\%$ loss). To approximate heavy-tailed returns, which can matter in this context, returns distribution in the simulation is not Gaussian, but a Student with 6 degrees of freedom. The results are shown in Figure 9.2. There is a great deal of useful information in these charts.

- For a fixed value of the ratio max % loss to % annualized vol, the PnL to allocated vol is *always* smaller than the Sharpe Ratio, which is shown as a horizontal dotted line. This is intuitive. To control maximum loss there is a loss in risk-adjusted performance.
- The PnL to allocated vol is *always* smaller in the ten-year simulation than in the five-year one. This is also intuitive. When we stop a PM with, say a Sharpe Ratio equal to one, we forgo a larger PnL in the ten-year case.
- The price of safety is higher for lower-Sharpe PMs than higher-Sharpe ones. You can see this in the steeper slope of the curve for high-Sharpe PMs. And this is intuitive. A two-Sharpe PM is not stopped as often as a one-Sharpe PM.

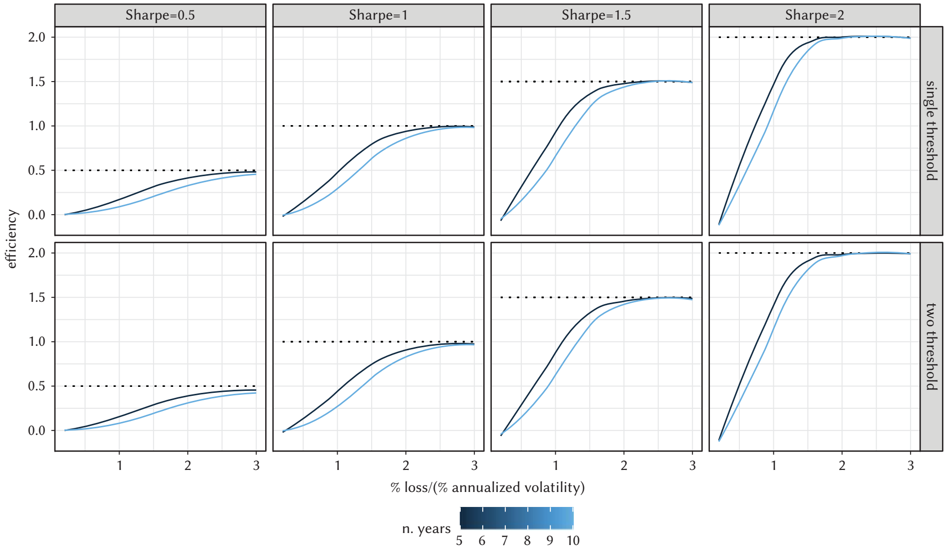

Figure 9.2 Impact of stop-loss on performance. We visualize five- and ten-year investment horizons.

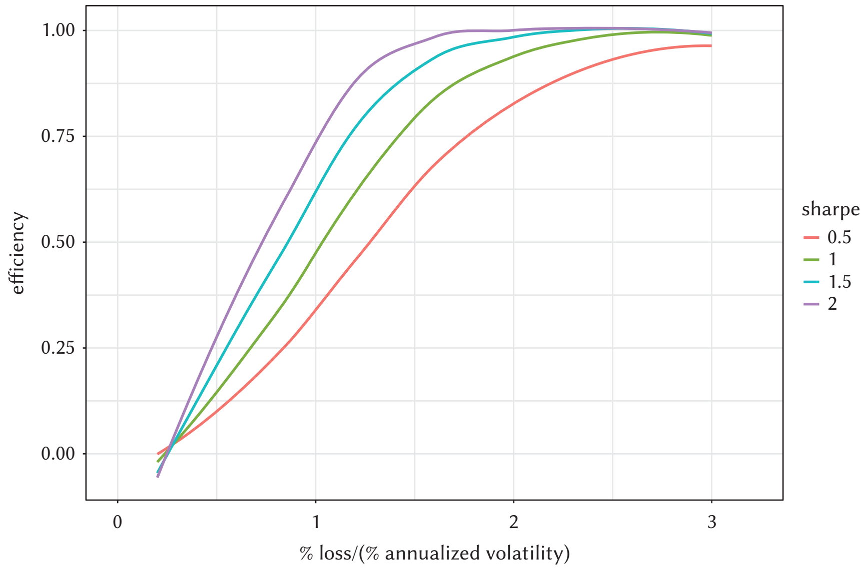

Figure 9.3 Relationship between efficiency of a strategy and stop-loss, based on five-year simulations.

- The difference between single-threshold and two-threshold stop-loss policies is negligible, a confirmation that the main benefit of the two-threshold policy is to encourage discipline in the liquidation process.

While Figure 9.2 is useful to understand the qualitative relationship between the many parameters that, in addition to stop-loss, affect realized performance, it is hard to derive some quantitative recommendations from them. Figure 9.3 addresses this issue. I focus on a five-year interval and on a single-threshold rule; this is closer to the typical tenure of a PM in a firm; in addition, the Sharpe Ratio of a PM should be reevaluated on a horizon of three to five years. The graph shows on the y axis, the ratio between the "realized performance" used in Figure 9.2, and the true Sharpe Ratio of the PM. We call this ratio the *efficiency* of the stop-loss rule. On the x axis is the stop-loss threshold, as a fraction of the PM's volatility. As a general rule, the stricter the stop-loss rule, the greater the loss in efficiency; however, the efficiency loss is (a) nonlinear in the normalized stop-loss threshold; (b) depends heavily on the Sharpe Ratio of the PM. Table 9.1

Table 9.1 Efficiency for different values of the PM Sharpe Ratio and the loss/vol ratio.

	Loss/Vol					
Sharpe	**1**	**1.2**	**1.4**	**1.6**	**1.8**	**2**
0.50	0.33	0.47	0.58	0.69	0.76	0.83
1.00	0.47	0.62	0.75	0.85	0.90	0.93
1.50	0.64	0.79	0.88	0.93	0.97	0.98
2.00	0.78	0.88	0.96	0.98	0.99	1.00

presents some of the efficiency data. If we set a normalized stop-loss threshold of 1.4, the efficiency is 96% for a PM with a Sharpe Ratio of 2, but only 58% for a PM with a Sharpe Ratio of 0.5. In other terms, we can interpret the curves in Figure 9.3 thus: the trade-off is initially steeper for high-Sharpe PMs, as shown by the fact that the purple line has a larger slope than the red one, but the trade-off is less likely to affect the PM, because for typical values of the stop-loss thresholds (say, between 150% and 250% of the PM's volatility) a high-Sharpe PM is unlikely to be affected while a low-Sharpe PM will suffer a sizable efficiency loss. What lesson can we draw from this? The price of certain downside protection is high. A PM with a native Sharpe Ratio of 1 and a stop loss equal to 1.5 times her volatility has a realized Sharpe of 0.8. If the firm has four PMs with this performance and uncorrelated returns, the realized Sharpe (before fees) goes from 2 to 1.6.

9.4 Takeaway Messages

1. Explicit or implicit, stop-loss rules are ubiquitous and necessary.
2. They serve several purposes:
   - As a form of put option to offset the call option owned by the PM.
   - As a form of tail portfolio insurance.

3. Stop-loss rules have two drawbacks:
   - Transaction costs due to trading induced by de-grossing and re-grossing portfolios.
   - Performance degradation due to forgone profits.
4. Differences between the simple rule of single-threshold and two-threshold stop-loss are small.
5. Performance degradation is a bigger concern than transaction costs. Choose the stop-loss threshold for your strategy or for PMs in your firm, based on trade-off curves in the chapters.