Risk: Defining it, Measuring it, and Managing it

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The investment business has spawned a thriving sub-business devoted to the measurement of risk. This sub-business features a variety of wonderfully sophisticated approaches to the measurement of price volatility. But the measurement of volatility does not improve our understanding of risk, since the essence of risk is not volatility, but uncertainty. Indeed, highly precise measures of volatility can get in the way of intelligent risk management by suggesting a level of accuracy and control that does not exist.

I. Defining Risk

Whatever risk is, it is not the annualized standard deviation of the daily (or weekly, or monthly) returns. Nor is it value at risk, measured at the 95% (or 99%, or 99.9%) confidence level. Nor is it semi-variance, or shortfall probability, or any other simple quantitative measure. These various measures may shed light on risk, and may help us to estimate risk, but they do not define the nature of risk.

People worry about risk in a wide variety of non-financial situations where the various measures just mentioned would not apply at all. When people worry about whom to marry, what college to attend, or whether to accept a certain job, they weigh reward against risk, benefit against cost, upside against downside, but they do so without the elaborate quantitative machinery available to every investment professional. The quantitative machinery is not essential to risk assessment, and may even hinder intelligent risk assessment.

The key element in risk analysis, both in the financial arena and other arenas, is a form of scenario analysis in which the risk-related questions boil down to these: What are the possible bad outcomes? How likely are they? How bad are they? In some situations it may be possible to attach numerical values to the probabilities and the “degree of badness,” in other situations that will be impossible. If Jane is trying to decide whether to marry John, it would be absurd to assign definite probabilities and definite “disutility units” to all the different ways in which a marriage can go wrong. Even someone worried about the risks of airplane travel would have a hard time calculating the probability of dying as opposed to the probability of losing a limb. And he would have an equally hard time quantifying the difference in undesirability of those outcomes, despite the fact that the flight insurance policy might pay ten times more for death than for the loss of a limb. In many situations the most that we can do is to order the scenarios, without being able to measure them. We can say that this outcome is more likely than that one, or this outcome is more undesirable than that one, without being able to attach definite values to the probabilities or the level of undesirability.

Financial professionals tend to think that investment risk is more easily quantifiable than marriage risk, career risk, and air travel risk, but this is an illusion. Investors have access to an endless stream of numbers, and access to many ways of crunching those numbers, but that does not mean that the numbers measure risk as we ordinarily understand it. We all know the story about the man looking for his keys at night under the lamppost. The joke is that he is looking under the lamppost not because the keys are there, but because the light is better.
there. The numbers can shed a tremendous amount of light, but the keys may be somewhere else.

If we had to offer a simple definition of risk it would be something like “expected pain,” which would combine some rough measure of the likelihood of various unfavorable outcomes with some rough measure of how unfavorable those outcomes are. This simple definition at least captures the fact that risk judgments depend on two elements: the likelihood of various painful outcomes, and the level of pain associated with those outcomes. Think of the difference between AM radio and FM radio. AM radio works by modulating the amplitude of the signal, FM radio works by modulating the frequency of the signal. Risk combines frequency with amplitude. But this definition is, of course, an idealized oversimplification, since in most real-life situations we have no real hope of measuring either the probabilities or the level of pain. Investment situations give us the opportunity to measure standard deviations, values at risk, and all sorts of other numbers, but that is not the same as measuring risk.

II. Measuring Risk

Since standard deviation is the most common proxy for risk (even VAR measures are driven ultimately by standard deviation), the easiest way to approach the problem of risk measurement is to catalogue the various inadequacies of standard deviation as a risk measure.

**Volatility vs. Uncertainty.** Standard deviation can be either a measure of uncertainty or a measure of volatility. Suppose, for example, that we are running a portfolio optimizer using a set of inputs that includes the assumption that US stocks will have a return of 12% and a standard deviation of 15%. The 15% figure can be interpreted as an estimate of the volatility of stocks over the forecast period, or can be interpreted as a measure of how much uncertainty attaches to the return estimate. In the first case we are estimating total return over the full investment horizon, and are then making an additional estimate regarding the character of the return over smaller time periods. In the second case, we are estimating total return over the full investment horizon, and then indicating how much confidence (or lack of confidence) we have in that estimate. In the first case we are making two forecasts, in the second case we are making a forecast and then adding a disclaimer regarding the forecast.

To drive home the contrast between volatility and uncertainty, consider the difference between a 10-year zero coupon bond and a venture capital partnership requiring a 10-year lock-up of capital. The bond investor can be certain of the return (*i.e.*, the nominal, pre-inflation, return) on his investment, but he also knows that the investment will be highly volatile when marked to market on a regular basis. The venture capital investment has no price volatility, because it is non-marketable, but the investment still offers substantial uncertainty, hence risk.

A volatile investment is likely to be an uncertain investment, except for special cases (like the zero coupon bond) where a volatile investment might produce a certain return if held to the end of a definite period. And even in those cases, volatility will create uncertainty for any investor whose holding period is itself uncertain. On the other hand, uncertainty need not
involve volatility, as the venture capital example illustrates. So the concept of uncertainty has much broader investment application than the concept of volatility. Indeed, “risk as uncertainty” covers career risk, air travel risk, and all sorts of other situations, whereas “risk as volatility” applies only to the marketable portion of the investment arena.

The distinction between volatility and uncertainty is central to the idea that long-term investors have a competitive advantage over short-term investors. Most investors have greater confidence in their long-term return estimates than in their short-term return estimates. For example, many people are confident that US stocks will outperform US bonds over the next ten years, but have no idea whether stocks will beat bonds over the next two months. For these investors, adopting a long-term investment horizon does not reduce volatility, but it does increase their confidence in their expectations. This reduces the level of uncertainty, thus enhancing their ability to tolerate volatility. The art, of course, is to make sure that confidence does not become over-confidence, which is the major source of investment disasters.

**Volatility and Path-Dependence.** Even when we focus our attention specifically on volatility, not uncertainty, standard deviation is a very imperfect measure. When investors talk about “volatile markets” sometimes they mean volatility of price, sometimes they mean volatility of return. These two concepts are totally distinct, and both have nothing at all to do with the order of prices or returns, since the calculation of standard deviation pays no attention to order. To see these points, consider the following three sequences of prices and returns. In each of the three cases the total return over the full time period is 2%. Panel A shows what looks like a very volatile, or choppy, market, in which prices move up and down in a narrow band, ending up 2%. In Panel B the prices are the same as in Panel A, but the order of the prices is changed, hence the returns change. The standard deviation of prices is the same between A and B, but the standard deviation of returns is dramatically reduced. In Panel C we take the returns from Panel A but change the order, so all the positive returns come together and then all the negative returns. The prices in Panel C are very different from
the prices in Panel A, with much higher standard deviation than in Panel A, but the returns, and hence their standard deviation, are the same in both A and C.

Panel A clearly looks more volatile than B, and this difference is reflected in the difference in standard deviation of returns. The difference between A and C is more complicated. The standard deviation of returns is the same in both cases, but the returns in A are much more jagged than in C, so the returns may look more volatile. The prices in C have a higher standard deviation than the prices in A, but which series of prices looks more volatile? The prices in C move in a much wider band, but the prices in A are more jagged. Markets that look, or feel, volatile often feel that way because of a distinct order of prices or returns: an order that involves choppy movements with frequent reversals. This kind of “order-dependent volatility” is not captured by the technical definition of standard deviation, since standard deviation is not sensitive to order.

This point has direct application to hedge fund investing, since many hedge fund managers employ trading strategies whose success or failure will be related not to the volatility of markets but to the path that markets follow. Consider, for example, the difference between convertible hedging (and other forms of “delta-hedging”) and systematic trend following. The delta hedger might do unusually well in a market of big price moves and sudden reversals, and would suffer in a listless market with few trading opportunities. But the systematic trend-follower would be whipsawed in an environment of sharp reversals, since the new trend would trigger a buy signal just as prices were about to turn down, and would trigger a sell signal just as prices were about to turn up.

Many of the terms that investors use to describe “difficult” markets, such as choppy, trendless, whipsaw, etc., are implicitly order-sensitive or path-dependent. These terms are therefore not analyzable in terms of standard deviation, which is path-independent. We at Evaluation Associates Capital Markets have experimented with various tools to measure choppiness and related notions (e.g., the number of times that the daily price crosses the \( n \) day moving average), but we are not yet satisfied with any single tool. And we know that, no matter which tool might seem the most appropriate, we will not be able to predict the transitions from choppiness to trendiness and back.

**Standard Deviation and Downside Risk.** Many people object to standard deviation as a risk measure because standard deviation gives equal weight to deviations above the mean and deviations below the mean, whereas investors are likely to be more worried about “downside deviation” than “upside deviation.” According to this view, the most relevant returns are returns below the mean, or below zero, or below some other “target” or “benchmark” return. This has lead to a proliferation of measures of “downside risk”: semi-variance, shortfall probability, the Sortino ratio, etc. Ignoring the specific advantages and disadvantages of each individual candidate to represent “the true nature of risk,” we would offer two general observations:

**Frequency vs. Amplitude.** The idea of risk as “expected pain” combines two elements: the likelihood of pain, and the level of pain. The measures described above focus on one or the other of these elements, but not both. Semi-variance (and its descendant, the
Sortino ratio) focuses on the size of the negative surprises, but ignores the probability of those surprises. Shortfall probability focuses on the likelihood of falling below a target return, but ignores the potential size of the shortfall. If we were forced to embrace a single quantitative measure of risk, we would offer the concept of “expected return below the target,” defined as the sum of the probability-weighted below-target returns. This measure is essentially the area under the probability curve that lies to the left of the target return level. (Note that this definition is broad enough to cover both normal and non-normal distributions.)

To illustrate this idea, suppose that the annual returns of US stocks are normally distributed with a mean of 12% and a standard deviation of 15%. Assume further that our target return is zero, so the favorable outcomes all feature a positive return while the unfavorable outcomes all feature a negative return. We can easily calculate that the probability of falling below the target is 21.2%. But this probability figure covers a region that includes small losses, large losses, and very large losses. For example, there is an 8.3% probability of achieving a return between zero and -5%, and a 1.0% probability of achieving a return between -20% and -25%. What we need is the mean below-target return, where that mean, multiplied by the probability of achieving the below-target return, will be the expected below-target return. If we consider a standardized normal distribution, with a mean of 0, a standard deviation of 1, and a target return whose standardized value is \( z \), then the expected below-target return is

\[
\frac{-1}{\sqrt{2\pi}} e^{z^2/2}
\]

and the mean below-target return is the above amount divided by the probability of achieving a below-target return. Returning to the example of US stocks, and making the appropriate adjustments for the mean of 12% and standard deviation of 15%, then the expected below-target return is -1.8%, which reflects a 21.2% probability of achieving a mean negative return of -8.5%. The expected above-target return is 13.8%, reflecting a 78.8% probability of achieving a mean positive return of 17.5%. The expected below-target return of -1.8%, added to the expected above-target return of 13.8%, gives the expected total return of 12.0%.

**Asymmetrical Samples of Symmetrical Distributions.** Measures of downside risk are most appealing in situations where there is reason to believe that the underlying distribution of returns is asymmetrical. But the evidence for such asymmetry can be very murky, except for very specific situations where the underlying investment process involves long positions in options. An investor who is long options is willing to accept the high probability of a small loss in exchange for the small probability of a large gain. The potential gains are much greater than the potential losses, but the likelihood of gain is much smaller than the likelihood of loss. Here there is genuine asymmetry, and a readily understandable source of asymmetry. But if you are dealing with a string of market returns, or manager returns, that are attractively skewed, you should be very cautious about inferring that the underlying return distribution is skewed in the same way. The more likely scenario is that you are dealing with a skewed sample from a symmetrical population. Skewed performance records have a nasty tendency to turn symmetrical very soon after you invest real money with the manager. In such cases, downside risk measures would have underestimated the potential
risk, while plain old standard deviation would have been a better indicator. Except for the specific case of long options strategies, it is prudent to believe in investment gravity: whatever went up a lot could have gone down a lot, and may well go down a lot in the future.

**Predicting Risk.** Past performance does not guarantee anything regarding future performance, and past risk does not guarantee anything regarding future risk. This is true even when the historical record is long enough to satisfy normal criteria of statistical significance. The problem is that, just as a performance record is getting long enough to have *statistical* significance, it may no longer have *investment* significance. Because the people and the organization may have changed in important ways over the years, and the strong historical record may be a prominent driver of those changes. Top-performing hedge fund managers hardly ever retire at the top of their game: the risk is that they will fade away, or blow up.

Fading away is just another example of the universal phenomenon of reversion to the mean. A manager who has compiled an excellent historical record gradually turns into just another manager, with higher risk than before, and lower return. Maybe he has lost his competitive edge, his hunger for success; or maybe the historical record was just a fluke, not really a symptom of genuine investment skill. In any case, what looked like an exceptional investment opportunity turns into a disappointment: not a disaster, but a disappointment.

The blow-up syndrome takes us from the category of disappointment into the category of disaster. The pattern here goes roughly as follows: a manager puts together a superb performance record, which increases the size of assets under management and dramatically boosts the manager’s confidence in his own investment prowess. At some point confidence becomes complacency, complacency becomes hubris, hubris creates errors, and the errors breed disaster. The unwinding of Long Term Capital Management, as well as the recent overhaul of the Soros organization, are examples of this phenomenon. In each case, genuinely exceptional investors pushed the envelope until the envelope pushed back. The irony here is that long records of strong performance, which are the records that investors love to see, are precisely the records that should create the most anxiety. Andy Grove, the Chairman of Intel, is famous for emphasizing that only the paranoid survive. Skilled money managers need to be paranoid about factors that may jeopardize the sustainability of their success. And prudent investors need to be paranoid about factors that may turn a golden record into lead.

### III. Managing Risk

Given all these problems about measuring risk and forecasting risk, it might appear that risk management would be an impossible task. How can you manage what you can’t measure? We would take the contrary position: a proper appreciation of the difficulties of measuring risk actually *improves* one’s ability to manage risk. Those who overestimate their ability to measure risk, who have too much confidence in the sophistication of their quantitative tools, are precisely the ones most likely to get into trouble.
In constructing a multi-manager hedge fund portfolio it is essential to have a clear view of the risk profile of the individual managers, and a clear view of the way in which those risk profiles interact within the context of a portfolio. We are not talking about a set of numbers for each manager and a correlation matrix tying those numbers together, we are talking about a practical working understanding of risk. A Lamborghini may be preferable to a Chevrolet on a closed-circuit racecourse, but the Chevrolet is probably the better bet for city driving.

**Manager Risk Factors.** The risk factors that we identify at the manager level are organized as follows:

**Portfolio Factors: Non-Market Related**

- Leverage
- Concentration
- Illiquidity
- Trading behavior: cut losses vs. average down

**Portfolio Factors: Market-Related**

- Directional factors: long bias, short bias, neutral, opportunistic
- Technical factors: volatility, choppiness, etc.
- Spread-related factors:
  - Equity: big/small, growth/value, etc.
  - Fixed income: maturity spreads, credit spreads, etc.

**Organizational Factors:**

- Length of record
- Assets under management
  - Rate of growth
  - Nature of client base
- Ownership/compensation structure
- Risk monitoring/control systems

The thinking behind this schema is very straightforward. We want to distinguish between risk factors that will show up within the portfolio, and factors more related to people and organizations. Among the portfolio-related factors, the first group comprises those factors that can be understood by looking at the manager’s portfolio and by seeing how it changes through time. Many of these factors are factors that lie within the control of the manager. The market-related portfolio factors are those that can be understood only by looking more carefully at the ways in which the manager’s returns are affected (either positively or negatively) by the behavior of market-related factors.

Within the first group of factors, the first three items require no special comment but the fourth factor goes to the heart of the risk control problem. Some managers are deeply averse to losses: if a position moves against them, their tendency is to exit the position first, ask
questions later. Other managers are more contrarian, or value-oriented: if a position moves against them, the position is now even more attractively priced, hence the manager may be tempted to add to the position on weakness. Managers in the first category tend to have a shorter investment horizon than managers in the second category. At the extremes, both approaches are self-defeating. The excessively loss-averse manager becomes so impatient that he cannot withstand any adverse movements, the result being enormous trading costs and no profits. The excessively value-driven manager becomes so convinced that he is right, the market wrong, that his hands remain frozen to the wheel as his portfolio crashes into the wall. In the real world, away from the extremes, the issue is to locate the manager, at least roughly, on the spectrum between “cut your losses quickly” and “buy low, buy more lower.”

Within the group of market-related risk factors, the directional factors are mostly self-explanatory. It is comparatively easy to assign managers to the long bias, short bias, and market neutral categories. The opportunistic category is more complicated. This category is reserved for those managers who have the mental flexibility to vary their net portfolio exposure from net long to net short and back. But, in the real world, managers often turn out to be less flexible than they originally appeared. Throughout the course of the powerful US equity bull market that began in 1982, many managers who appeared to be opportunistic wound up fighting the tape with portfolios that were chronically net short. For these managers, “short biased” turned out to be the more appropriate category.

The technical factors are especially important for those managers who are either market neutral or opportunistic. Even if a manager does not have an enduring directional bias, his returns may be affected (either positively or negatively) by such factors as volatility, choppiness, etc. As we discussed earlier, a convertible hedger might thrive in an environment of sharp reversals, whereas a systematic trend-follower would struggle in such an environment.

The spread-related factors are particularly crucial for those managers who profess to be market neutral. For example, an equity-oriented manager might be neutral to the broad market, but still have a tendency to be long value and short growth, or long small capitalization names and short large capitalization names. The portfolio would thus contain major style bets even in the absence of any market directional bets. This can be seen in the fixed income world as well. For example, hedge fund managers sometimes construct “hedged” positions in which the long side emphasizes high yield corporate bonds, or emerging market debt, while the interest rate risk of the long side is “hedged” with short positions in US Treasury bonds (or futures, or other derivatives). But these so-called hedges are really just spread trades in which the manager is betting that the non-Treasury leg of the trade will outperform the Treasury leg. The trade will fail if the yield spread widens, and will fail dramatically in the special case where the long side of the portfolio falls for sector-specific reasons, while the short side rallies on a flight to quality. That was exactly the case in the fall of 1998, when emerging markets debt fell in response to the Russia/LTCM crisis, while US Treasuries rallied sharply in a stampede for safety.

The organizational factors speak for themselves. One needs to be cautious about managers whose assets have grown very fast, whose client base includes significant amounts of “hot
money,” etc. Ownership and compensation need to be structured so as to create incentives for good people to stay, and the manager needs to have systems in place that demonstrate his own concern for risk monitoring and management.

**Prevention vs. Cure.** Preventing disease is usually much cheaper, and more effective, than curing disease. The same is true in risk management: *staying out of trouble* is much more effective than *getting out of trouble*. The keys to *avoiding* a crisis are diversification, prudent levels of leverage and liquidity, and a continuing respect for one’s own fallibility. The keys to *managing* a crisis are more limited and less satisfactory: either do nothing, or reduce positions sharply. Doing nothing is often the right thing to do, and will certainly appeal to the longer-term, value-oriented manager, but sometimes the temptation to do something can be overpowering. Reducing positions seems very prudent (the manager is, after all, “protecting the value of his portfolio”), but the implementation costs are enormous, since the manager is selling long positions that may be in free-fall and covering short positions that are spiraling upwards. For managers with a very large asset base, or a preference for less liquid situations, risk control in the sense of “crisis management” is simply not a realistic alternative. The only viable form of risk control is to stay out of trouble in the first place.

**IV. Prudence**

Risk is complicated, and risk management is complicated, so we are chronically suspicious of the idea that risk can be boiled down to a single number. A proper appreciation of the complexities of risk is an essential part of being a prudent investor. And prudence, like risk, cannot be boiled down to a single number. For the last word on prudence we turn to the US government, whose nautical charts are indispensable for those who need to find their way about on the water. Every US chart bears this warning: *The prudent mariner will not rely solely on any single aid to navigation, particularly on floating aids.* Investing is just like navigating, except that there are only floating aids.

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