A Practical Guide to Risk Management (a summary)

Thomas S. Coleman

Risk management is the art of using lessons from the past to mitigate misfortune and exploit future opportunities—in other words, the art of avoiding the stupid mistakes of yesterday while recognizing that nature can always create new ways for things to go wrong.

True risk management is about much more than numbers; it is the art of using numbers and quantitative tools to actually manage risk. Risk is a central, maybe the central, component of managing a financial organization. But risk management has something of a split personality. Managing risk is as much the art of managing people, processes, and institutions as it is the science of measuring and quantifying risk. A Practical Guide to Risk Management addresses that split personality—one side soft management skills, the other side hard mathematics—with an emphasis on how to think about risk.

There are two preliminary issues before turning to risk management itself. The first is to recognize the importance of a consistent risk framework throughout the organization. The second is to think carefully about risk, randomness, and uncertainty.

Consistent Risk Framework

The underlying foundations for thinking about, discussing, and measuring risk can and should be consistent throughout the various divisions and levels of an organization. Measuring and reporting risk in a consistent manner throughout the firm provides substantial benefits. Although reporting needs to be tailored appropriately, it is important that the foundations—the way risk is thought of and calculated—be consistent from the granular level up to the aggregate level.

The measurement of risk, the language of risk, seemingly—even the definition of risk itself—all these can vary dramatically among assets and among the levels of a firm. Traders may talk about DV01 (the dollar value, or impact, of a 0.01% interest rate change on a portfolio’s value) or adjusted duration for a bond, beta for an equity security, the notional amount of foreign currency for a foreign exchange position, or the Pandora’s box of delta, gamma, theta, and vega for an option. A risk manager assessing the overall risk of a firm might discuss volatility, value at risk (VaR), expected shortfall, or lower semivariance.

Published 2011 by the Research Foundation of CFA Institute
Summary prepared by Thomas S. Coleman
This plethora of terms is often confusing and seems to suggest substantially different views of risk. Nonetheless, these terms all tackle the same question in one way or another: What is the variability of profits and losses (P&L)? Viewing everything through the lens of P&L variability provides a unifying framework for asset classes and for levels of the firm—from an individual equity trader up through the board.

Consistency provides two benefits. First, senior managers can have the confidence that when they manage firmwide risk, they are actually managing the aggregation of individual units’ risks. Senior managers can drill down to the sources of risk when necessary. Second, managers at the individual-desk level can know that when there is a question regarding their risk from a senior manager, it is relevant to the risk they are actually managing. The risks may be expressed in different terminology, but when risk is calculated and reported on a consistent basis, the various risks can be translated into a common language.

**Risk, Randomness, and Uncertainty**

Managing risk requires thinking about risk, and thinking about risk requires thinking about and being comfortable with uncertainty and randomness. It turns out that, as humans, we are often poor at thinking probabilistically. We like certainty in our lives and thinking about randomness does not come naturally; probability is often nonintuitive. We should not abandon the effort, however; just as we can learn to ride a bike as a child we can learn to think probabilistically. Doing so opens horizons, allowing us to embrace the fluid, uncertain nature of our world.

Randomness pervades our world. Experience and training do not always groom us to understand or live comfortably with uncertainty. In fact, a whole industry and literature are based on studying how people make mistakes when thinking about and judging probability.

While it is true that thinking about uncertainty is difficult and human intuition is often poor at solving probability problems, we should not get carried away. Human intuition is also ill suited to situations involving quantum mechanics, special relativity, or even plain old classical mechanics. That limitation does not stop us from developing DVD players and MRI scanners (which depend on quantum mechanics) and GPS devices (requiring both special and general relativistic timing corrections). These devices are not intuitive; they require science and mathematics to arrive at correct answers, and nobody is particularly surprised that quantitative analysis is required to inform, guide, and correct intuition. In the realm of probability, why should anybody be surprised that quantitative analysis is necessary for understanding and dealing with uncertainty?

We should be asking how good the quantitative tools are and how useful the quantitative analysis is, not fretting that intuition fails:
The key to understanding randomness and all of mathematics is not being able to intuit the answer to every problem immediately but merely having the tools to figure out the answer. (Mlodinow 2008, p. 108).

Gigerenzer (2002) has a refreshing approach to the problem of living with uncertainty. He argues that sound statistical (and probabilistic) thinking can be enhanced through training and through appropriate tools and techniques. He aims to overcome statistical innumeracy through three steps:

1. Defeat the illusion of certainty (the human tendency to believe in the certainty of outcomes or the absence of uncertainty).
2. Learn about actual risks of relevant events and actions.

These three steps apply as well to risk management. Most work in risk management focuses on the second—learning about risks—but the first and third are equally important. Thinking about uncertainty is hard, but it is important to recognize that unexpected things happen; the future is uncertain. And communicating risk is especially important.

**Quantitative Risk Measurement**

Before asking, “What is risk measurement?” we need to ask, “What is risk?” This question is not trivial; risk is a slippery concept. To define risk, we need to consider both the uncertainty of future outcomes and the utility, or benefit, of those outcomes. When someone ventures onto a frozen lake, that person is taking a risk not simply in the sense that the ice may break but in the sense that if it does break, the result will be bad.

Financial risk is, in some ways, so simple because it is all about money—P&L and the variability of P&L. The future outcomes that matter for financial firms are profits—measured in monetary units (that is, in dollars or as rates of return). Future outcomes are summarized by P&L, and the uncertainty in profits is described by the distribution, or density, function. The distribution and density functions map the many possible realizations for the P&L, with profits sometimes high and sometimes low or negative.

Consider an extremely simple financial business—betting on the outcome of a coin flip. We make $10 on heads and lose $10 on tails. We could graph the P&L distribution as in Panel A of Figure 1. The probability of losing $10 is one-half and the probability of making $10 is one-half. This kind of distribution is fundamental to how we should think about financial risk. It shows us the possible outcomes (possible losses and gains along the horizontal axis) and how likely each of these is (probability along the vertical axis).
For managing risk, the main thing that we want from the P&L distribution is an understanding of how variable the P&L can be. In this example, it is simple: either –$10 or +$10.

Panel B of Figure 1 shows a more realistic P&L distribution. The possible losses and gains are along the horizontal axis, but in contrast to Panel A, there may be any of a wide range of possible outcomes. The most likely outcome is somewhere around zero, but there is some possibility of large profits and some possibility of large losses.

Financial risk measurement is really nothing more than what is shown in Figure 1—the P&L distribution. When we know the P&L distribution, know the possibilities of gains versus losses, when we understand what generates the distribution and what causes those gains and losses, then we understand virtually everything we can about financial risk.

In practice, although risk is represented by the distribution of future P&L, we will rarely know or use the full P&L distribution. We will use summary measures that tell us things about the distribution because the full distribution is too difficult to measure or too complicated to easily grasp or because we simply want a convenient way to summarize the distribution. The most important aspect of the distribution (from a risk management perspective) is the variability, the dispersion, the spread of the distribution. We would like a single number that would tell us the dispersion of the distribution. But there is no one best way to summarize the dispersion. Indeed, the “dispersion of the distribution” is a rather vague concept. Like learning to live with uncertainty itself, we have to learn to live with some vagueness and ambiguity in describing the variability or dispersion of the P&L distribution.
There are two common measures used to summarize the dispersion or variability: volatility (also known as standard deviation) and VaR. When properly used, volatility and VaR are both useful. They will, by and large, tell us the same information, although there will be times when they can provide meaningfully different views of the distribution.

The easiest way to understand volatility and VaR is to work with a simple example. Say we own $20 million of a 10-year U.S. Treasury bond. The distribution for a one-day P&L would look something like Panels A and B in Figure 2. Volatility and VaR are calculated in different ways, but both describe what is the spread, or dispersion, of the distribution. (For details on the calculation of volatility, VaR, and many other risk measures used throughout the industry, see Coleman 2012).

Figure 2. P&L Distribution for U.S. Treasury Bond Showing Volatility and VaR

A. Volatility (standard deviation)

B. VaR
The most important aspect in using volatility, or VaR, is understanding what it tells us and how to use the information. Panel A of Figure 2 helps us understand how to use volatility. The volatility tells us the spread for the distribution. For most well-behaved distributions, roughly 30% of the outcomes will be better or worse than the volatility. For our bond, the volatility is $130,800, so we should expect that 30% of the time, or roughly one day in three, the result will be worse than −$130,800 or better than +$130,800.

How do we use this information? We need to examine such things as our internal tolerance for gains versus losses and the firm capital that is available to absorb losses. Can the firm live with a loss of $130,800 on a regular basis? How much does such a loss worry me? Does it make my stomach churn? Or is that loss really small, maybe too small? And remember that $130,800 sets the level for “standard trading conditions” and that the P&L will be between −$130,800 and +$130,800 two days out of every three. But that third day can sometimes be a very bad day; every once in a while there will be losses much worse (or profits much better) than $130,800. How much worse? For full answers, refer to A Practical Guide to Risk Management or Coleman (2012), but for now, simple gut feeling gets us a long way—maybe asking if you would lose your job if losses were three or four times that amount. These questions start to set a scale for how much risk is in the $20 million T-bond position.

Volatility is one number that summarizes the spread (calculated by taking the average of squared deviations and then taking the square root). VaR is another number that summarizes the spread. It is calculated by setting the chance of worse losses at, say, 5%.

It is absolutely critical to remember that what really matters is the underlying P&L distribution and that the volatility and the VaR are simply two ways of summarizing the spread of that distribution. Sometimes one measure is more useful; sometimes, the other.

How would we use the VaR? In much the same way as volatility—as a way of helping our gut determine whether we have too little or too much risk. For our T-bond example, the 5%/95% VaR is roughly $215,000, so we should expect to see losses worse than that roughly 5% of the time, or 1 day out of 20. Can we live with this kind of loss? Again, we can ask our gut whether we would be comfortable seeing such losses once a month, or losses maybe two or three times larger on a yearly basis. If that is too much, then the risk may be too high. If we would not even notice because the portfolio is so large, maybe the position is too small.

**Risk Management as Management**

We cannot lose sight of the most important aspect of risk management—managing risk. That means making the tactical and strategic decisions to control those risks that should be controlled and to exploit those opportunities that should
Uses and Limitations of Quantitative Techniques

A key component of true risk management is an appreciation of not only the power but also the limitation of quantitative risk techniques. Quantitative techniques work best in the hands of those who understand the techniques but who are also keenly aware of the limits and boundaries of what these techniques can provide. A deep appreciation of the limitations gives the user the confidence to rely on the techniques when appropriate and the good sense to turn elsewhere when necessary. Like most helpful tools, these techniques work well when used properly, and the key is to understand their limitations in order to avoid misusing them.

Like any set of techniques or tools, risk measurement has definite limitations. This condition is not a problem; it is simply the way the world is. Appreciating risk measurement limitations helps us understand when and where quantitative
techniques are (and are not) useful. Failure to understand the limitations of risk measurement techniques, however, is a problem. Misusing the techniques in the face of limitations leads to mistakes, misunderstandings, and errors.

Following are some of the limitations of quantitative risk techniques. These characteristics are often cited as criticisms of the whole approach, but in fact, they are merely limitations that we should understand and learn to work with.

- **Models for measuring risk will not include all positions and all risks.** The models used to measure VaR, volatility, or whatever else will never include all positions and all risks. Positions may be missed for a variety of reasons. Similarly, the risk of positions that are included may not be properly represented. Missing positions and missing risks mean that the risk measures reported will not perfectly represent the actual risk. In reality, nobody should be surprised. A risk system should be viewed as a tool for summarizing and aggregating a large amount of information in a concise manner. Such a system will not be perfect, and users should recognize that in using the results.

- **Risk measures such as VaR and volatility are backward looking.** Quantitative techniques can tell us things about how a portfolio would have behaved under past conditions. This is not a criticism or a weakness of risk measurement techniques. It is simply the way the world is: We can seek to understand the past, but we cannot know the future. Understanding the past is terribly important because understanding current exposures and how they would have behaved in the past is the first step toward managing the future. As the philosopher George Santayana said, “Those who cannot remember the past are condemned to repeat it.”

- **VaR does not measure the worst case.** Statistical measures such as volatility, VaR, expected shortfall, and others provide summary information about the dispersion of the P&L distribution and will never tell us the worst case. VaR is often talked about and thought about as a “statistically worst-case loss,” but that is a horribly misleading way to think. Whatever VaR level we choose, we can always do worse, and in fact, we are guaranteed to do worse at some point. Litterman (1996) recommends thinking of VaR “not as a worst case, but rather as a regularly occurring event with which we should be comfortable” (p. 74, note 1). Thinking of VaR as a worst case is both intellectually lazy and dangerous. It is intellectually lazy because a so-called worst case relieves us of the responsibility for thinking of the consequences and responses to yet worse outcomes. It is dangerous because it is certain that results will, at some point, be worse.

- **Quantitative techniques are complex and require expertise and experience to use properly.** General managers and board members have a responsibility to understand the complex businesses they oversee. The financial
business overall, not risk measurement alone, is complex and is becoming more complex all the time. Managers at financial firms should take their responsibilities seriously and learn enough about the business, including risk measurement, that they can effectively use the available tools.

Risk professionals have the corresponding responsibility to explain their techniques and results to nonexperts in a simple, concise, transparent manner. Most of the ideas behind risk measurement are simple, even if the details necessary to get the results are complex. Simple ideas, clear presentation, and concise description must be the goals for anyone engaged in measuring risk.

- **Quantitative risk measures do not properly represent extreme events.** Quantitative risk measures do not catch extreme events. Experience does not catch them either. Imagination can try, but even that fails. Extreme events are extreme and hard to predict. That is just the way life is. We need to recognize this limitation, but it is hardly a failure of risk techniques. To criticize the field of risk measurement because we cannot represent extreme events well is silly—like criticizing the sky because it is blue. Anybody who does not like extreme events should not be in the financial markets. Luck, both good and bad, is part of the world. We can use quantitative tools to try to put some estimates around extreme events, but we have to learn to live with uncertainty, particularly when it comes to extreme events.

Failure to appreciate our limitations, however, is a serious mistake. Overconfidence in numbers and quantitative techniques and in our ability to represent extreme events should be subject to severe criticism because it lulls us into a false sense of security. Understanding the limitations does not mean, however, throwing out the tools that we have at our disposal.

**References**


