Holistic Risk Management for Perpetual Portfolios: Keeping an Eye on What's Important

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Introduction

Risk is inseparable from the investment process. Investment theory and practice both teach that without the assumption of risk by an investor there can be no possibility of return. The willing assumption of risk by a knowing investor, who expects thereby to achieve a measure of return, can be said to lie at the heart of the investment process.

Yet the measurement of risk, and its management within the context of an investment portfolio, may often be misunderstood – even by senior investment professionals who may otherwise be quite sophisticated in the analysis of individual securities and classes of investment. The purpose of this paper is to describe and analyze the various types of risk that confront investors in the context of perpetual pools that support mission-based organizations such as educational endowments, charitable foundations and other long-term tax-exempt funds, and to review strategies for measuring, analyzing and managing or controlling those risks. While not a 'how-to' guide, this paper is intended to provide a road map for those charged with the management of perpetual investment pools who want to know more about risk management policies and procedures and their application to the funds they supervise.

Please see important legal disclosure at the conclusion of this paper.

A critical part of understanding and evaluating risk from the standpoint of perpetual pools is to grasp the concept that much of what investors learn and intuit about risk does not apply to these funds. Portfolios that support mission-based organizations have a different standard in evaluating risk than other types of investment pool. Some of these critical differences are:

- These pools of assets have a time frame which is perpetual – longer than that of any other type of investment program.
- Ultimately, success will be evaluated by the effectiveness of the investments in producing a steady and growing stream of distributions that at least keeps pace with inflation.
- Inflation measures for nonprofit institutions are generally higher than those for consumers, due in large measure to the comparatively labor-intensive nature of nonprofits' activities.
- The reputational impact of one poor investment could have a substantial effect on the financial well-being of the institution.
- To achieve long-term objectives, not taking risk is the biggest risk of all.

The first part of this paper will outline the concept of risk in the investment of perpetual pools, and will describe the various types of risks. The remainder of the paper will be devoted to a review of techniques and practices that can be used in managing these risks.

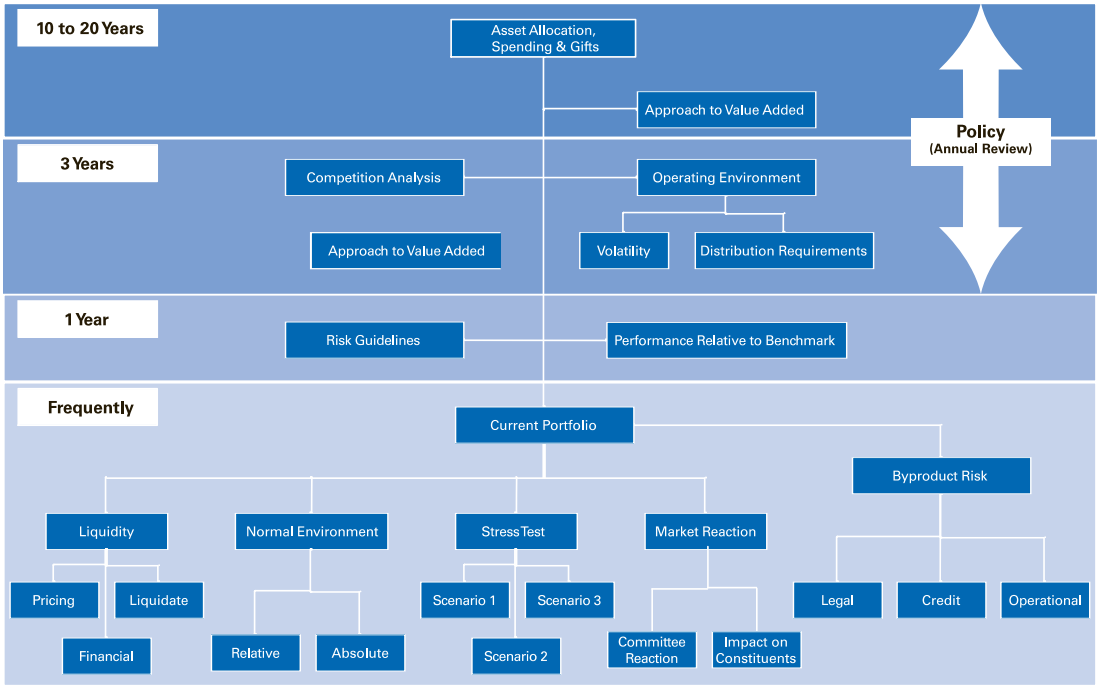
Risk in the Context of Portfolio Investing

Webster defines risk as 'the possibility of loss or injury'[1]. The financial profession – borrowing from Modern Portfolio Theory – views risk as the standard deviation of a portfolio's returns. But an approach that equates risk with volatility suffers from being too narrow to be truly useful for portfolio investors. This is because volatility is a price concept, which focuses on market risk while ignoring the other types of risk that exist. It is also overly dependent upon statistical models that, while useful, make assumptions that are not always present in real-life situations. Perhaps most important, statistical volatility measures alone fail to explain or anticipate abnormal markets and large market movements – situations in which the risk of loss may be greatest.

For a nonprofit, mission-driven organization, risk may be defined in a more strategic sense as the possibility of a failure to meet the organization's commitments to its beneficiaries, arising from its inability to earn a sufficient inflation-adjusted return to cover a given period's distribution requirement. While many investors think of risk primarily in terms of market risk, many other sources of risk – such as processing of investment transactions, custody of securities, legal and regulatory matters, and fraud – also have the potential to impair the mission of an organization. The consequences of ignoring them can be profound and long lasting.

Time is an important dimension of risk, and it can be viewed from multiple horizons. To better analyze these interrelationships, it can be helpful to envision the 'risk waterfall' shown in Figure 1. In this diagram, the time horizon on the left ranges from decades (for decisions on asset allocation, spending and gifts) to monthly (for monitoring key risk elements such as liquidity and market risk). This diagram will form the framework for our discussion.

Figure 1: Risk Management Framework



[1] *Webster's Seventh New Collegiate Dictionary, 1971.*

The main financial imperative for a nonprofit organization is to maintain intergenerational equity, as measured by achieving a real long-term return – after spending – that at least equals inflation. More concretely, the portfolio must earn investment returns sufficient to support its mission annually. It is the role of the trustees of an institution to determine the portfolio's asset allocation, distribution rate and method, and endowment gift policy in order at least to maintain the purchasing power of the pool. The largest long-term risk is for the pool to lose its ability to contribute to the organization's mission.

In this regard, many nonprofits fail to take full advantage of their ability as perpetual pools to give up short- to medium-term liquidity in favor of greater long-term return. While liquidity certainly needs to be monitored, research indicates that the actual liquidity needs of most nonprofits appear to be well below the levels currently maintained in long-term portfolios. It has been observed that the largest, and most successful, nonprofit investment portfolios are in fact those that are also the least liquid – or, to put it another way, whose liquidity is more closely matched with the actual spending requirements of the institution, thereby freeing assets for investment in longer-term, less liquid, strategies that offer the possibility of higher total return.[2]

Over a somewhat shorter time frame of five to ten years, it is important that an organization understand the factors that influence its position in the marketplace – for example, the risks borne by its competitors and how those risks can be evaluated relative to its own position ('Competition Analysis' in Figure 1). While not all nonprofit organizations think of themselves as competing with each other, many sectors, such as education and health care, are far from being immune to competitive pressures.

During this same time frame, a broader risk analysis should be conducted to examine how dependent the organization's operations are on the long-term asset pool. This risk relates to the impact on the mission of the volatility of the perpetual pool's distributions. It is important to understand how the possible outcomes of the asset allocation and distribution policy relate to the impact on operations ('Volatility' in Figure 1). Directly related to that issue is the degree of liquidity required by the pool to meet the prescribed distribution (e.g., forcing equivalent cuts in crucial programs as a result of volatility in distributions) ('Distribution Requirements' in Figure 1).

The analysis of risk should not omit the question of the board's approach to adding value to the policy portfolio, which will influence the risks that the organization takes. For example, if the trustees determine that they will not attempt to add value to the policy portfolio and therefore index all of the asset classes, they will create a different set of risks than they would by using active management in an attempt to add value and mitigate risk relative to the index. And if in following an indexation strategy an institution uses pooled funds, that will create different risks than those incurred using index futures. Understanding the approach to adding value relative to the overall long-term investment policy is necessary to provide a framework for risk monitoring.

[1]*See Verne O.Sedlacek,* "Looking at Liquidity in a New Light", Mission Matters*, Fall 2006/Winter 2007, pp. 2-7.*

Risk Management: Issues and Structure

With this long-term strategic framework as background, we can turn to the shorter-term monthly risks defined in Figure 1. These include portfolio liquidity; market risks in normal and abnormal environments; the reactions of the institution's investment committee and constituents (such as donors) to market events; and the legal, credit and operational factors that are the byproducts of the investment process.

Most analytical tools assume an environment of normal markets and make simplifying assumptions which are not always present in real investing environments. They are therefore unhelpful in evaluating the potential effects of extreme events upon a portfolio:

- Efficient or liquid markets do not always remain that way.
- Not all asset return profiles are linear, nor are they all normally distributed.
- Not all information that is relevant to an investment decision is reflected in the price of the security.

Examples of abnormal conditions include periods of high market stress, when securities whose price movements had previously been uncorrelated display an unexpectedly high degree of correlation, thereby negating the effects of diversification; and 'fat tail' situations, where the expected loss significantly underestimates the actual loss incurred in an investment strategy, due to inadequate consideration or pricing of all its risks – some of which do not lend themselves to being quantified. Adequate management of risk, therefore, requires a holistic view of risk combined with a willingness and ability to integrate quantitative and qualitative approaches. Standard analytics must be supplemented with stress and scenario testing.

Risk Bucketing

While the collection and aggregation of data are critical to facilitating the evaluation of risks at the manager level, the most important objective is to achieve an understanding of the overall risks of the portfolio and to identify outside risks that are a result of a roll-up of multiple scenarios. Risk bucketing allows an investor to use common categories to measure risk in a multi-manager portfolio while leaving room for the unique, possibly subjective measures that are essential to understanding each manager's risk and return profile.

Traditional risk groupings such as industry, exchange listing, credit rating, maturity, country or region, and market capitalization, while easy to understand and implement, are not meaningful when used to analyze securities having both linear and non-linear return profiles or strategies having relative (*e.g.*, benchmark) vs. absolute (*e.g.*, a fixed target percentage above a hurdle rate) return objectives. This is because most traditional risk measurement techniques, while well-suited for specific asset classes (such as a domestic equity portfolio) or particular forms of investment management (such as long only), become muddled or meaningless when these approaches are mixed, as they would be in a well-diversified portfolio. An example of this mixing would be potential concentrations in an issuer name or sector in both the equity and fixed income markets: in the current environment, holding mortgages in the fixed income portfolio and mortgage company stocks in the equity portfolio will compound risk beyond the level that would be apparent if each portfolio were examined separately.

To find common denominators that can harmonize these differences, it is important to use a risk-factor framework based on fundamental and discrete risks that are meaningful for all security types in a portfolio, while still maintaining a holistic view of risk. In Figure 1, these factors are aggregated into four major 'buckets' – those relating to *liquidity*, those relating to *market risks* in a *normal environment*, those that are used in *stress tests* of the portfolio, and those that attempt to estimate the *market reaction* to various events.

Liquidity risk is defined as the extent to which the more liquid portion of the portfolio can be turned into cash on a timely basis without suffering a substantial discount from the prices at which these positions are currently being carried. There are two risk measures to evaluate when examining liquidity risk in the context of a sale of assets. The first is how much of any given portfolio is valued using prices in markets that are actively traded. This is defined as *pricing risk*. To quantify the amount of pricing risk, each portion of the total fund should be examined for positions that have stale prices or are valued on a basis other than a market price – for example, positions that are valued by the portfolio manager or by using a model. The higher the percentage of positions that are valued by a source other than a relatively actively traded market, the higher the liquidity pricing risk and the more likely it will be that the institution fails to obtain proceeds equivalent to the value at which the position is being carried in the portfolio.

The second part of liquidity risk is to analyze, for those positions that are valued using a traded market price, how quickly they could be turned into cash. This risk is a function of the *size* of the position held by the institution relative to the trading volume of the particular instrument in the market. To examine how quickly each position could be sold, it must be evaluated relative to the average daily trading volume of the security over a period of time. For example, if based on the average daily trading volume all positions could be sold within half a day, the portfolio can be said to have a low liquidity risk.

Another way to evaluate liquidity risk is to examine how quickly cash can be generated without a sale of assets. In Figure 1, this is identified as *financial liquidity*. If cash is needed to meet a short-term liquidity strain, an institution can raise money by lending stocks or bonds on a fully-collateralized basis. The simplest and most cost-effective way to do this is through stock lending or repurchase agreements. To have this ability, an entity must have an agreement in place with a broker-dealer. A further refinement of financial liquidity involves understanding how much could be borrowed against the investment positions currently held. The larger the borrowing capacity, the less liquidity risk exists.

Risk in normal markets: There are two types of market risk outlined in Figure 1:

The first is market risk in a *normal environment*. This refers to the identification of risks in markets that are operating within the usual bands. Within this 'normal' category, there are two types of risk. The first is *absolute risk*: how much can a portfolio lose in normal markets in total dollar terms? This measure is an effective tool in understanding potential short-term downside risks.

The second type is *relative risk*. This is the risk that a portfolio may underperform the market in normal market environments when evaluated against a suitable benchmark. This measure will in many cases be more relevant than absolute risk, since the overall asset allocation or policy portfolio determines the amount of relative risk an institution is willing to take. To the extent that decisions are made that create exposures which are outside the benchmark, this is a potential source of additional risk.

Stress testing: The normal environment defines risks under stable market conditions that prevail most of the time. However, it is crucial to examine the risks that can occur outside of normal times. This is where stress testing comes in. Stress testing evaluates risks that arise under market conditions which are abnormal and occur less frequently. The objective is to examine how the portfolio would perform in this extreme environment, both on an absolute basis and relative to the policy benchmark.

In performing stress tests, various scenarios – including both up markets and down markets – should be analyzed. They should include some past events, like the market crash of 1987 or the Russian debt default of 1998. They can also include potential stress events such as a terrorist attack or a significant shift in interest rates. Stress testing allows the leadership of institutions to understand where significant losses can take place due to hidden concentrations of risk that might only be harmful in very extreme conditions. Understanding how a portfolio might react in a very difficult environment can also help the investment committee and management to make preemptive changes in the portfolio or to develop contingency plans that can be put into action if an extreme event takes place.

Market reaction risk can be divided into two categories: the *investment committee's reaction* to an event, and the impact of that event on *constituents*. The first refers to the risk that an unprepared investment committee will do exactly the wrong thing when a major event takes place – for example, sell stocks when the market is down, or fire liquid managers that will bounce back when the market recovers. Here, a secure knowledge of the various types of risk can help an institution's management to prepare and review contingency plans in advance. When a market event occurs, the organization can make better decisions, choosing from a range of possible steps that have been studied and weighed, and explain those decisions clearly to the investment committee. The second risk is that constituents such as donors or faculty will react negatively to a loss in the portfolio. For example, a total loss on a hedge fund investment in a small portion of the portfolio could have a significant impact on donations that extends well beyond the immediate financial loss.

Byproduct Risks – Certain risks are external to the portfolio and result from what may be called the byproducts of the investment process. They are *legal, credit*, and *operational* risk.

Legal risk – This term refers to losses that could result from legal factors, including litigation, regulatory and documentation issues. Key legal risks can range from failing to secure the appropriate governmental approvals and licenses to operate the entity, through failures to abide by the organization's charter and by-laws, to matters of employment law

Risk Aggregators

Risk aggregators are organizations that collect and analyze portfolio information gathered from numerous sources, including both traditional investment managers and alternative strategy managers such as hedge funds. The aggregators' method for measuring risk has broad application: portfolio details can come from single-strategy or multi-manager funds, and from multiple asset classes. Given this input, the risk aggregator then provides a report containing quantitative measurements of specified risks that may be associated with individual portfolios, as well as the relative risks that individual portfolios appear to be contributing in the case of fund-of-funds managers.

How do they work? The aggregator links the individual securities that are in a portfolio to a pricing model. The model values the change in price of each of the securities based upon moves within the financial markets. Market conditions are simulated using upwards of 1,000 factors that may be relevant to their respective markets. The price sensitivities of bonds, swaps and other derivative instruments can be simulated using direct factors such as yield curves, and the model may also incorporate other attributes of the securities, including coupon and maturity dates.

and building code compliance. On the investment side, legal risks can arise from a failure to perform adequate due diligence or to document clearly the relative responsibilities of the investing entity and its investment managers. It is also important to note that investment relationships can create different levels of legal risks. For example, limited partnerships may permit investors less ability to control parameters such as investment guidelines than separate accounts, but may provide them with greater legal protection against liabilities; and over-the-counter derivative instruments are likely to present more legal complexities than exchange-traded futures contracts. This is only a summary list; a nonprofit institution needs to keep up with changes in the legal and regulatory spheres, through briefings and advice from in-house or outside counsel, as part of its risk management program.

Credit risk – This term relates to losses that could be incurred due to declines in creditworthiness of an obligor or non-payment of obligations for which an investor is not otherwise being compensated. For example, an investor in a high-yield bond receives additional compensation in the form of higher interest. However, the investor also incurs credit exposure that is created as a byproduct of the investment process. Other examples of credit risk include the notional exposure on derivatives, including futures; stock lending / FX exposures; and the counterparty risk in unsettled trades, among others. When evaluating credit risk, it is common either to rely upon an assessment from a rating agency or to develop an internal rating, possibly relying as well on external analysis. The nature of the work performed can vary significantly between firms and is highly dependent on the characteristics of the specific issues (e.g., issue size, concentration, or the extent of non-rated securities).

An investor needs to be able to answer, with a reasonable degree of confidence, the question of what its aggregate credit exposure is to the defaulting entity, measured across all types of instrument. With traditional instruments, this amount is readily calculated. In derivative contracts, however, this exposure is only present when there is a positive net payment due on a mark-to-market basis to the institution; and when evaluating credit risk on a derivative, the amount at risk is not only the exposure on the current unsettled trade but the amount at risk that could be generated based on the volatility and settlement method for the instrument in question.

Operational risk – This is broadly defined as the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events. This is often the most overlooked form of risk, and can also be the most disastrous: examples include the collapse of Baring Brothers and the Kidder Peabody bond trading scandal. It can include exposure to direct losses such as assets that are stolen or physically damaged, litigation costs, human error resulting in the irrevocable transfer of assets or funds, unexpected staff costs, regulatory penalties, or project failure. Indirect operational risks also exist, such as brand erosion, loss of market share, unforeseen turnover in key staff, loss of key customers, and increased insurance costs.

Unlike liquidity, market and credit risks, operational risk does not lend itself to quantitative oversight and its analysis tends to be a very qualitative endeavor.

Some of the main advantages of using risk aggregators are:

- **Transparency:** Investment managers may be more open to disclosing current position details to an intermediary, rather than directly to a current or potential investor. This adds an element of transparency that may not otherwise be achievable.
- **Objectivity:** Aggregators are more likely to provide a neutral view of the risks associated with particular portfolio investments.
- **Scalability:** Aggregators are able to quantify, through common metrics, the risks associated with a variety of asset classes and portfolio strategies.

Risk aggregators' limitations include:

- Data limitations. The historical data used are based on recent market performance – which may not be indicative of the conditions that are being modeled. As a result, the market conditions that are simulated may either be overly stable, or in the other extreme, too volatile. To simulate portfolio performance for specific market events, stress tests and 'what if' scenarios can be performed.
- Overreliance on quantitative data. Although risk measurement models are commonly used for the purpose of evaluating and quantifying risk, the qualitative side of the risk analysis process is equally – if not more – important for the purpose of arriving at a holistic understanding of the risks to an investment or portfolio.

Tools for Measuring and Judging Risk

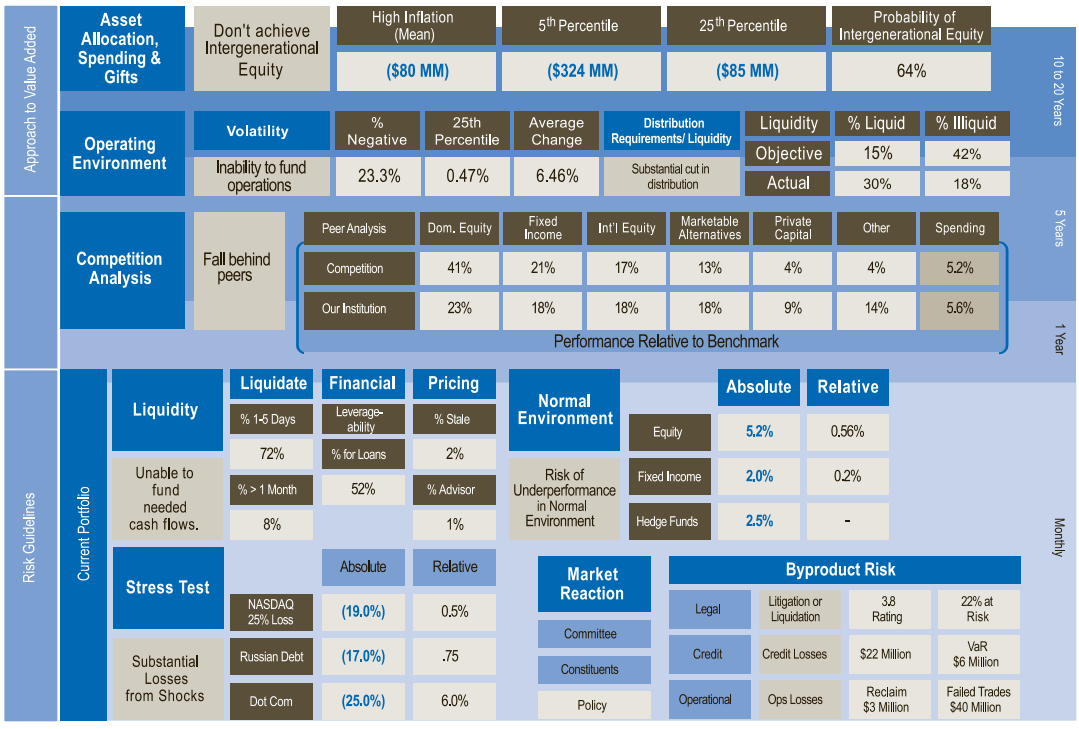
Keeping track of risk

The 'risk waterfall' depicted in Figure 1 can be used as a template to create the summary risk management report shown in Figure 2. This report serves as a 'dashboard' in which different types of risk can be monitored on an ongoing basis.

Position transparency vs. risk transparency

When operating in a multi-manager environment, the information received from managers is likely to vary – sometimes significantly – with regard to position transparency, return attribution, depth and quality of prices, and the extent of the firm's history and track record. For example, a manager engaged through a separate account to invest in large cap equities will hold securities that are very liquid and offer a high degree of transparency. In contrast, an alternative strategy offered through a commingled fund may not offer any position level transparency (and if it were offered, it might not be meaningful due to the nature of the strategy). It is therefore vital that the investor in the alternative strategy mitigate this discrepancy and seek *risk transparency* from the manager to understand the key risks being taken. A risk aggregator can be an essential and trusted agent to preserve manager confidentiality while harmonizing disparate data – with the caveat that it can never be a substitute for independent analysis (see sidebar).

Figure 2: Risk Management Framework: Summary Report



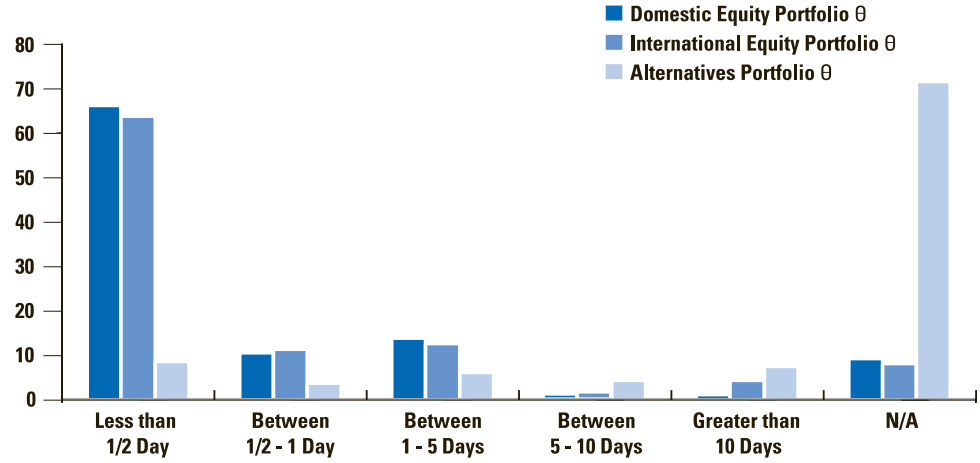
Hypothetical data

Measuring Portfolio Liquidity

The liquidity of a portfolio should be monitored regularly as a routine part of the risk analysis process. In Figure 3, liquidity for Hypothetical Portfolio θ is defined as the time it would take to liquidate 20 percent of the portfolio, based on average daily trading volumes.

On the whole, the two equity portfolios offer the highest degree of calculated liquidity, with Domestic Equity Portfolio θ being the most liquid. 76.1 percent of Domestic Equity Portfolio θ and 74.5 percent of International Equity Portfolio θ can be sold in one day. Alternatives Portfolio θ does offer some liquidity, with a total of 11.7 percent that can be turned into cash in one day.

Figure 3: Liquidity in Hypothetical Portfolio θ



Portfolio						
Domestic Equity Portfolio θ	65.9%	10.2%	13.5%	0.8%	0.8%	8.9%
International Equity Portfolio θ	63.5%	11.0%	12.3%	1.3%	4.0%	7.8%
Alternatives Portfolio θ	8.3%	3.4%	5.8%	4.0%	7.2%	71.3%

Normal markets: Value at Risk as a measurement tool

Introduction

Value at risk ('VaR') is a probabilistic measure which attempts to determine the maximum loss that a portfolio can incur over a specified time period and at a specified probability level. Developed initially by J.P. Morgan & Co. to help measure the capital at risk in the firm's trading businesses, it has received more visibility recently as regulators have incorporated its use for risk-based oversight into the Bank for International Settlements' Basel II[3] capital adequacy measurements. VaR is an excellent measure of risk and changes in risk, describing normal environments (*i.e.*, those that prevail 95-99 percent of the time).

VaR has two important characteristics: it provides a common and consistent measure of risk across different positions and risk factors, and it takes into account the correlations between different risk factors so that, if two risks offset each other, VaR accommodates this offset and shows the net exposure.

[3]*Basel Committee on Banking Supervision,* International Convergence of Capital Measurement and Capital Standards: A Revised Framework *644 (2004)("Basel II").*

VaR, however, also has limitations. Like other traditional risk measures, VaR attempts to forecast the future by using past data, based on the assumption that certain past correlations will persist. In addition, all VaR approaches are based on the assumption that return patterns are normally distributed – which is not always the case. Moreover, while VaR does provide a statistical measure of possible loss during stable times, it is not a 'worst case' scenario and so can understate the amount of the actual loss to which an investor may be exposed. Perhaps most important for a long-term investor, many portfolios hold securities or utilize investment approaches that are not suitable for analysis using VaR: they have neither linear payoffs nor normal return distributions, instead exhibiting 'fat tails' that cannot be ignored when measuring risk (*e.g.*, options). In sum, while VaR is a powerful tool, it is not foolproof and cannot be a substitute for intelligent judgment.

One example of how VaR can be used is in *stress testing* (see below), where VaR can be calculated under the assumption that the correlation of all asset classes in a portfolio is one. In Figure 4 on page 13, for example, the total VaR of the three portfolios is less than the total VaR that results if the three portfolio VaRs were summed. That is because the portfolios have diverse attributes relative to one another. The exercise of simply summing the VaRs provides a view into the portfolio risk that would be incurred if the correlations among the asset classes were to go to one.

VaR and market risk in normal market environments

The VaR metric enables an investor to estimate, with a degree of confidence, the potential downside of a given portfolio during a normal market environment. Unique to the VaR metric is its ability to capture the diversity of the portfolio. For illustrative purposes, a hypothetical portfolio is shown in Figure 4: one that includes equity, fixed income and alternative asset classes.

In Hypothetical Portfolio θ, Equity Portfolio θ's VaR implies that there is a 95 percent probability that it will lose no more than 4.1 percent, or $551.1m:

$$\text{Prob}\{\delta V \leq -\$551.1\text{m}\} = 0.05$$

On the basis of the VaR metric, Equity Portfolio θ contributes the highest level of risk at 4.1 percent, with the lowest contributor to risk, 0.3 percent, associated with Fixed Income Portfolio θ.

Refinements on VaR

Some of the weaknesses of VaR may be mitigated by using a more refined model. For example, the reliance on normal return distribution may be circumvented by using a full valuation-based Monte Carlo historical simulation method, based on a 'brute force' valuation approach that revalues all trades with a minimal number of simplifying assumptions or approximations. Such a model generates returns on a random basis rather than relying entirely on historical data. All cash flows are modeled and calculated at the time horizons where they actually occur, rather than using the compression techniques that are a part of many VaR models. The risk engine generates multi-variate, log-normal rate paths for market instruments that are used to establish a base case mark-to-market valuation using both current and third-party pricing. VaR results are reported on a 95 percent confidence level over a one-month time horizon.

This analysis may be enhanced further by using three other VaR-based measures, as shown in Figure 4:

Marginal Value at Risk (MVaR) captures the contribution of a specific position, portfolio, asset class or risk factor to the total risk, enabling an investor to examine positions or portfolios in relation to one another. The lower a specific portfolio's MVaR, the lower the risk it is contributing to the overall portfolio. MVaR is determined by calculating the VaR for the overall portfolio, systematically removing the accounts or instruments that the investor does not wish to value, and re-calculating the VaR. The difference between the two VaR measures is the marginal contribution of the remaining group of accounts or instruments to the portfolio risk. Use of this measure can facilitate optimal allocation of risk capital and portfolio rebalancing. In Figure 4, Fixed Income Portfolio θ, which has a positive MVaR in dollar terms, is actually reducing the risk of the overall portfolio because it provides diversification. Equity Portfolio θ, whose MVaR stands at 3.7 percent, is contributing more risk to the Model Portfolio than Alternatives Portfolio θ, which has an MVaR of 2.0 percent.

Conditional Value at Risk (CVaR) is used to measure the risk of loss in excess of that calculated by the VaR for a given confidence interval, thereby providing insight into the size of the 'tail risk' for a given security or portfolio. It is calculated by averaging the 'tail' of Monte Carlo simulations beyond the confidence interval. In Figure 4, Equity Portfolio θ yields the highest CVaR of 5.0 percent, while Fixed Income Portfolio θ yields the lowest, of 0.4 percent. Notice that the CVaRs are all higher that the VaRs. This is because CVaR is measuring the average risk of the 'tails'.

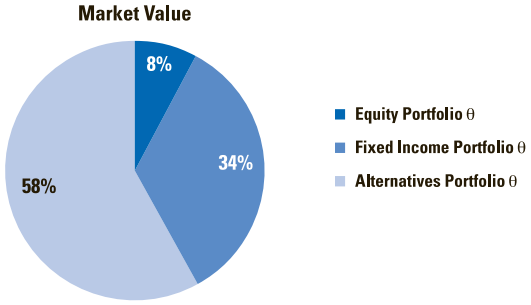
Relative Value at Risk (RVaR) measures how closely a portfolio's risk matches that of its corresponding benchmark (e.g., S&P 500 or Russell 2000) and provides a measure of the risk of underperforming a specific benchmark. To the extent that an investor does not own the relevant index, it is taking on risk relative to the long-term portfolio. One method of calculating RVaR involves first calculating VaR for the benchmark. The benchmark is then sold short against the actual portfolio and the VaR is recalculated. In Figure 4, at a 95 percent confidence level, Equity Portfolio θ could underperform its respective benchmark by 0.6 percent. The highest RVaR is associated with Alternatives Portfolio θ, with an RVaR of 1.3 percent.

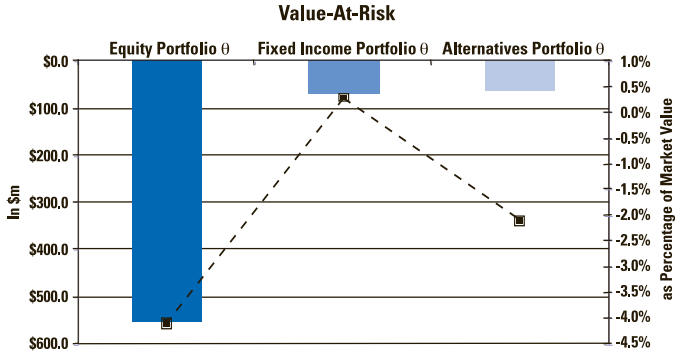
Figure 4: Measures of Value at Risk for Hypothetical Portfolio

	Size of Portfolio	VaR		Marginal VaR	
	$ m	$ m	△ %	$ m	△ %
Equity Portfolio θ	13,299.0	(551.1)	-4.1%	(489.4)	-3.7%
Fixed Income Portfolio θ	22,805.0	(68.1)	-0.3%	40.8	0.2%
Alternatives Portfolio θ	3,073.2	(63.3)	-2.1%	(60.5)	-2.0%
Total	39,177.2	(509.1) [1]	-1.3%	(509.1)	-1.3%

	Size of Portfolio	CVaR		Relative VaR	
	$ m	$ m	△ %	$ m	△ %
Equity Portfolio θ	13,299.0	(665.4)	-5.0%	(73.8)	-0.6%
Fixed Income Portfolio θ	22,805.0	(92.8)	-0.4%	(76.7)	-0.3%
Alternatives Portfolio θ	3,073.2	(76.7)	-2.5%	(41.0)	-1.3%
Total	39,177.2				

[1] The total VaR of Hypothetical Portfolio 0 is the sum total of the Marginal VaR





Stress testing

Stress tests, used in conjunction with VaR calculations, contribute to the quantitative portion of the risk analysis process. Stress tests enable an investor to look at various 'what if' scenarios and calculate how the portfolio might perform during extreme market events.

In Figure 5, several stress scenarios are evaluated. For example, Stress Test 5 shows that the equity and alternatives portfolios would have reacted positively when interest rates rose in late 1998. Equity Portfolio θ, based on the market conditions that existed during that time, would have seen a benefit of 11.0 percent, while Alternatives Portfolio θ would have appreciated 4.5 percent. Stress Test 4 shows that the market conditions that surrounded the market crash of 1987 would have hurt all three portfolios, with Equity Portfolio θ and Alternatives Portfolio θ seeing declines of 20.5 percent and 6.6 percent, respectively. In both scenarios, Fixed Income Portfolio θ would have seen the smallest relative moves in either direction, with a slight decline of 0.3 percent when interest rates steepened in 1998, and a decline of 1.0 percent during the crash of 1987.

Figure 5: Stress tests in different market environments

Stress Test 1: Sensitivity to an Equity Market Decline of 1 Percent		
	$ m	*% Decline*
Equity Portfolio θ	(129.3)	-1.0%
Fixed Income Portfolio θ	0.3	0.0%
Alternatives Portfolio θ	(14.2)	-0.5%
Stress Test 2: Sensitivity to Interest Rates Rising 5 Percent		
	$ m	*% Decline*
Equity Portfolio θ	2.3	0.0%
Fixed Income Portfolio θ	(123.4)	-0.5%
Alternatives Portfolio θ	7.7	0.3%
Stress Test 3: Sensitivity to Foreign Currency Declines of 1 Percent		
	$ m	% Decline
Equity Portfolio θ	(34.6)	-0.3%
Fixed Income Portfolio θ	(2.9)	0.0%
Alternatives Portfolio θ	(6.5)	-0.2%
Stress Test 4: Sensitivity to the Crash of '87		
	From 10/13/87-10/19/87	
	$ m	*% Decline*
Equity Portfolio θ	(2,728.4)	-20.5%
Fixed Income Portfolio θ	(229.4)	-1.0%
Alternatives Portfolio θ	(203.7)	-6.6%
Stress Test 5: Sensitivity to Interest Rates Steepening		
	From 9/29/98-11/17/98	
	$ m	*% Decline*
Equity Portfolio θ	1,461.8	11.0%
Fixed Income Portfolio θ	(69.5)	-0.3%
Alternatives Portfolio θ	139.3	4.5%
Stress Test 6: Sensitivity to a 25 Percent NASDAQ Rally		
	From 11/2/99-1/6/00	
	$ m	*% Decline*
Equity Portfolio θ	953.9	7.2%
Fixed Income Portfolio θ	(166.6)	-0.7%
Alternatives Portfolio θ	159.1	5.2%

Leverage in the context of liquidity, market and credit risk

The presence or absence of leverage can make a significant difference in the amount of an investor's risk exposure. While leverage is not in itself an independent source of risk, it can influence the rapidity with which changes in liquidity, market and credit risk factors affect the value of a portfolio. There are three basic forms of leverage:

Financing leverage refers to the practice of entering into a risk position by paying a premium for an instrument which provides exposure to an asset or set of assets under certain contractual conditions. Financing leverage can take the form of borrowing, such as is found in traditional loans, and notional leverage. This latter type arises as a result of entering into contracts such as swaps, options and futures, where a large amount of exposure can be purchased for a relatively small premium.

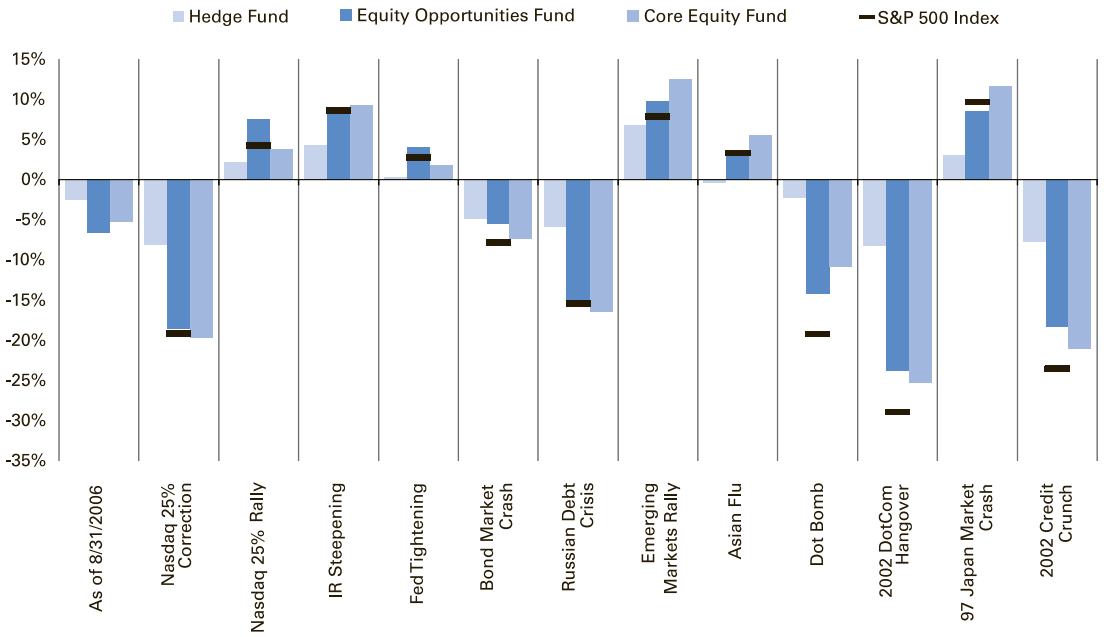
Instrument risk refers to the fact that different types of financial instruments contain significantly different degrees of internal leverage, varying in their specific sensitivity to changes in the broad market even if their nominal value is comparable. For example, a stock with a high beta represents a greater market risk than an instrument of the same nominal value that has a low beta. This difference represents a form of leverage.

Construction leverage occurs in investment portfolios as a result of both diversification (which reduces the correlation among positions in a portfolio) and offsets (where short positions act as hedges against long positions). For example, a portfolio of two technology stocks held long will generally have a higher expected risk than the same two positions where one is held long and the other short.

It is particularly important to aggregate the risk exposures within a strategy or portfolio before evaluating the degree of leverage. Observing trends in leverage may be more useful than any one leverage measure at a point in time.

Figure 6 shows some other examples of the effects of historical stress events on various types of investment.

Figure 6: Stress Test – Hypothetical Data



Perhaps most important, an investor should bring common sense and a healthy skepticism to the evaluation – tools which, while not quantitative, can help to avoid succumbing to widely-held – but wrong – opinions about the state of markets, portfolios and investments.

Managing Byproduct Risks

Credit risk

Significant research has been devoted to extending the Value at Risk methodology to the measurement of credit risk. Credit at Risk (CaR) enables an investor to estimate its maximum credit exposure at a certain statistical level of confidence. Default VaR, in contrast, provides an estimate of the maximum default loss at the same confidence interval.

These two measurement tools differ in important ways from traditional VaR. First, they require more informational factors and so there is more room for error in the estimation. In addition, they require that the investor analyze the particular credit exposure over longer and more frequent time periods, so longer data series are required. Both CaR and default VaR require that the investor analyze each counterparty separately, by position type and counterparty name – a tedious and time-consuming task. And the distribution of losses, when calculated, can exhibit the 'fat tails' referred to above: when losses do occur, they are much larger than would be statistically expected.

Apart from these quantitative tools, investors and portfolio managers can use more traditional business practices to manage credit risk:

- *Netting agreements* can reduce the amount at risk by setting off the notional or gross amounts owed by each counterparty against the other, so that only one smaller net payment is made at settlement.
- *Periodic settlement of open contracts* can reduce the likelihood of a major default by providing, in effect, regular testing of a counterparty's ability to pay.
- *Management of margin or collateral agreements* reduces risk by providing for regular review of the identity, resources and creditworthiness of counterparties and the soundness of custodial arrangements for the safekeeping of collateral.
- *Credit guarantees*, where available, can be important tools to increase the potential sources from which recovery can be sought in the event of a default.
- *Credit triggers* in lending and other agreements can put an investor on notice if a borrower's credit rating declines or its exposure levels increase.
- *Position limits*, traditionally thought of as a trading tool, can also be used by investors to control total exposure to a borrower or counterparty.

In a separate category, but increasingly useful as a tool for limiting exposure, are risk hedges such as credit derivatives, which enable an investor to purchase contracts that protect it against a decline in credit quality on the part of an entity to which the investor has exposure. As with other types of derivative instruments, credit derivatives are themselves subject to counterparty and credit risk, and have not yet been truly tested by a period of general market turbulence. For this reason, they are used with caution even by sophisticated investors.

Operational risk

Operational risk can lead to institutional failure, and its management therefore requires a more qualitative approach. Tools for managing operational risk include such seemingly mundane items as effective control systems which enable an entity to take advantage of process efficiency, demonstrate a sound system of internal controls, facilitate sharing of knowledge, enable the leveraging of technology, and facilitate prioritization of effort by employees and management.

The Basel Committee analysis of operational losses

- In a recent study done by the Basel Committee on international bank regulation[4], *execution, delivery* and *process management* events accounted for both the largest frequency and the largest individual amount of loss, followed by defects in *client, product* and *business practices* and *internal fraud*.
- In the study, several themes emerged as the root causes of the most common operational losses:
  - Misrepresentation of investments due to pricing and valuation errors
  - Misappropriation of funds (*i.e.*, general fraud)
  - Unauthorized trading and breaches of investment style mandates
  - A firm's having inadequate resources to fund its strategy

Asset Management Loss Events and Gross Loss Amounts for the 30 Reporting Banks

Event Type	Number of Loss Events	Gross Loss Amounts (exceeding 10,000)
Internal Fraud	4	8,566
External Fraud	4	603
Employment Practices and Workplace Safety	10	1,037
Clients, Products and Business Practices	32	8,968
Damage to Physical Assets	0	0
Business Disruption and System Failures	2	644
Execution, Delivery and Process Management	233	34,302
Total Across Event Types	285	54,120

Source: Investment Company Institute, Based on Tables 7 and 8 In Basel Committee (January 2002)

[4]*Basel Committee on Banking Supervision,* The Quantitative Impact Study for Operational Risk: Overview of Individual Loss Data and Lessons Learned, *January 2002.*

Competent staff are also often an overlooked asset. A small money manager may, for example, have a less formal risk management process than a large firm but if its personnel are experienced, intelligent and motivated, its system may be just as effective. While quantitative tools are of course useful in managing operational risk, they should be used prudently since many operational risks are difficult to quantify.

To evaluate operational risk, each manager and each investment asset class should be rated on a scale of 1 to 10. For example, managers pursuing long/short strategies should have a higher rating than those pursuing long-only strategies, reflecting their higher degree of operational risk. If U.S. Treasury instruments are rated 1, emerging market investments should be rated 7. OTC derivatives have more operational risk than futures; limited partnerships have more risk than separate accounts. While this kind of scoring system is qualitative, if it is applied consistently it enables an institution to make judgments about evaluating and changing operational risk over time.

Tracking and Monitoring Risks over Time

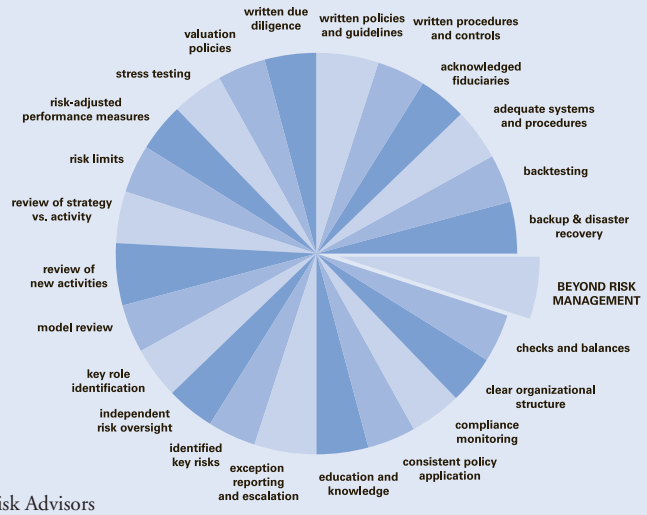
Recent history has provided numerous examples of how risks might have been better managed. Examination of these historical events and their magnitude can help an investor to estimate the damage that the next crisis might bring. For this reason, a prudent investor will regularly test its portfolios against a set of past events such as the stock market crash of 1987 and the Asian financial crisis of 1998.

Furthermore, because a single snapshot taken at a given moment in time is not an accurate picture of risk, it is important to view results over time in order to ascertain a manager's approach to risk in a dynamic context. An investor should ask the following questions when considering hiring a manager – and over the period of the investment:

Are the portfolio returns from this manager normally distributed?

As noted above, while most financial models – using the underlying tenets of Modern Portfolio Theory – assume that returns are normally distributed, this is not the case for all strategies or asset classes, and as the returns depart from a normal distribution the models become less useful.

Qualitative and Quantitative Risk Management Tools



Source: Capital Market Risk Advisors

Words to Live By: Touchstones for risk management practice

- Evaluate investment opportunities on a case-by-case basis
- Standardize analytical and measurement systems wherever possible
- Maintain effective communication, both externally (with managers and suppliers) and internally (among management, clients and staff)
- Emphasize the importance of tools for monitoring and tracking changes over time
- Consider both quantitative and qualitative approaches
- Keep the system as straightforward as possible: don't over-engineer the solution
- Continually ask: What haven't we considered?

For example, even traditional portfolio returns can be skewed if the manager has significant exposure to options; and in the hedge fund world, returns are typically asymmetrically distributed and highly skewed, with other statistical abnormalities that imply more extreme events than a normal distribution would predict. Leverage introduces a further complexity: when margin or derivatives are used, it is not always possible to find a common quantitative denominator for evaluating the portfolio.

What is the quality of the underlying data being used in the risk management process?

In alternative investing, it is often not possible to obtain useful position information from the manager. Furthermore, vehicles such as multi-strategy hedge funds have very broad investment mandates, and as a result position transparency can be limited or nonexistent. This fact restricts the amount and type of data that can be aggregated for analysis. In addition, for many alternative strategies, knowledge of position data alone is not sufficient to understand and measure the risks being undertaken.

What is the trading strategy?

Depending upon the strategy used, assets may possess more than one dimension of risk – and one or more of these dimensions may be obscured when the risks are placed in buckets. For this reason, it is important to consider portfolio construction before relying on quantitative risk measures.

The unknowable future

New events are always appearing on the horizon. Sometimes their advent can be foreseen, but sometimes they are truly new. The 'risk waterfall' in Figure 1 shows how potential loss amounts may be categorized and placed around various types of potential risk at various points in time. Quantitative risk management methodology, which by its nature uses databases of information from the past, is useful but will inevitably fail to capture all of these new developments. As a result, investors can end up placing reliance upon quantitative results that are not measuring the risks that the portfolio is in fact being exposed to. There therefore must be a qualitative component to any risk management effort.

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