Diversification and Risk Management: *What Volatility Tells Us*

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Every few years an event comes along that shocks financial markets. The majority of investors don't see it coming—that's the definition of a shock—and there is usually something different about the latest shock compared to the ones that came before. Previous crises include the dot-com bubble (2000–2001), Long-Term Capital Management (LTCM, 1998), and the 1987 stock market bubble, to name a few. As we write this (October 2008), we are in the midst of the subprime crisis of 2007–2008. While each panic has distinctive features, they also have elements in common. There is a sharp rise in risk aversion among investors, equity markets decline, credit spreads widen, confidence in financial institutions plummets, and volatility rises across asset classes. At the same time, there is a flight to quality—typically into bonds and short-term securities backed by creditworthy governments and into perceived stores of value such as gold. At such times certain currencies tend to perform much better than others, reflecting their safe-haven, or in times like the present safer-haven, characteristics.

Much research has been done in the past about the behavior of investments in times of volatility and financial crises. In light of current market conditions, we think it is timely to revisit some of this work.[1] The past 11 years contains three regimes of risk aversion. The period from mid-1997 (the onset of the Asian currency crisis) to mid-2003 was a period of elevated risk. That period included, in addition to the Asian crisis, LTCM, the dot-com bubble, 9/11, and the accounting scandals of 2002. Mid-2003 to mid-2007 was a period of declining risk aversion. Liquidity was abundant and economic growth and corporate profits were robust. Financial market returns were correspondingly healthy, although somewhat diminished as this benign four-year period drew to a close. As volatility declined, some market participants, hoping to maintain strong returns, increased leverage and other forms of risk-taking in their portfolios. Risk measurement tools that emphasized market behavior from the recent past may have encouraged complacency.

The third risk regime started in mid-2007. We do not know how long it will last, but if history is a guide, we can expect several years of elevated volatility. With this in mind, we have analyzed how selected investments perform in periods of rising risk aversion using the CBOE Volatility Index, VIX, as a proxy for risk. The analysis provides useful insight into the drivers of investment returns. We look at the characteristics of individual investments, and bring the analysis together in a sample asset mix. We show that most investments and typical institutional portfolios are highly exposed to rapid increases in risk aversion. This is not surprising given the heavy reliance on equity beta and related risk premia as return drivers. If investors wish to do more to protect

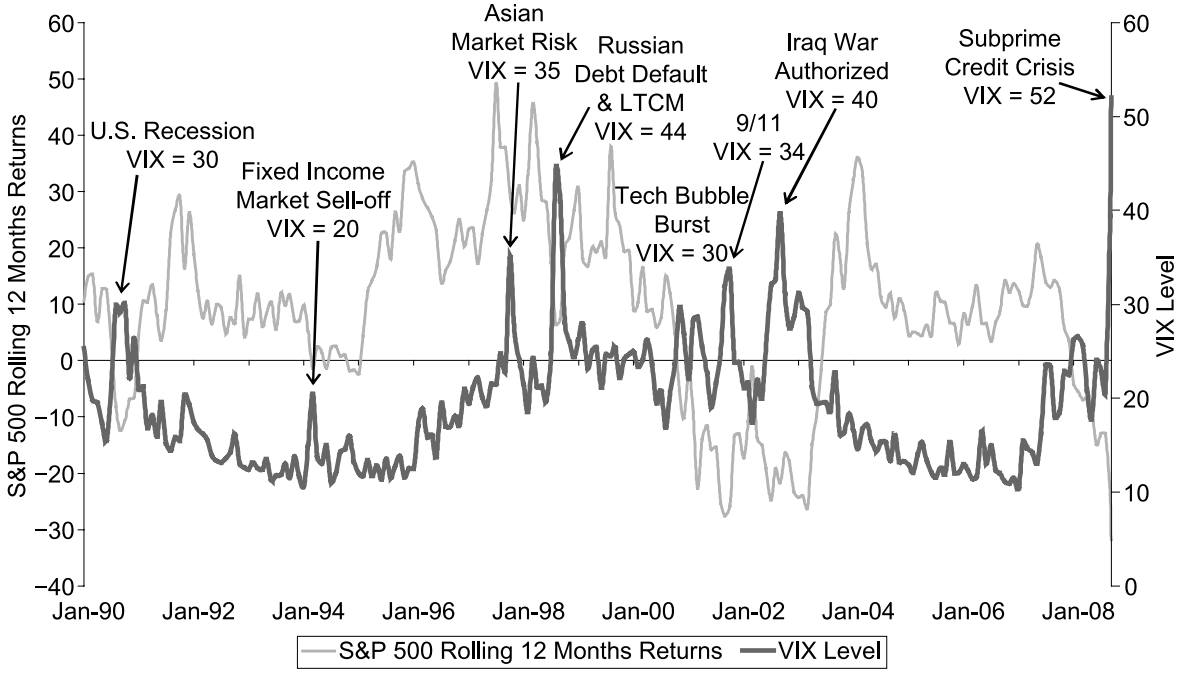
their portfolios from rising risk aversion, there are a limited number of asset classes and active strategies that can help without necessarily sacrificing expected returns. While greater reliance on active strategies is one possible approach, investors must take sufficient care, in the form of analysis and understanding, to ensure that the strategies under consideration are not likely to underperform as risk aversion rises. We believe that volatility analysis should be a standard component of an investor's toolkit.

VOLATILITY PROVIDES INSIGHTS ON INVESTMENT BEHAVIOR

The linkage between expected volatility and financial asset prices is well established in economic theory. Volatility is an important component of the discount rates used to establish value for financial assets. The dividend discount model used to value equity securities, for example, applies discount rates to future dividends. The discount rate is made up of a default-free interest rate such as the long-term government bond yield, plus an equity risk premium to compensate investors for the uncertain value of future dividends. The value of future dividends depends on many unknown factors, and the greater the uncertainty, the higher the equity risk premium and the higher the discount rate, which causes the equilibrium or "fair" value of equity securities to be lower. When the level of uncertainty is changing rapidly, stock prices will also be changing, and volatility will be high. Exhibit 1 illustrates the relationship between risk aversion, as expressed by the VIX, and equity returns.

The VIX is sometimes called the "fear index" because when the VIX increases, there is an expectation that stock market volatility will be rising, and many investors are unsettled by rising volatility.[2] Rapidly rising volatility in broad markets is more often associated with bad news than good news. We suggest a couple of reasons for this; there may be others. Positive developments at the broad market level tend to take place over an extended period of time. These may be related to rising productivity and earnings, and they unfold over a number of quarters and years. On rare occasions when there is a positive event that affects the entire market, such as an unexpectedly favorable new tax law, there is volatility as the market rapidly adjusts upwards. Positive shifts in volatility, however, are a small minority of market events. Bad news, or

EXHIBIT 1
Volatility versus S&P 500 Returns



Source: Chicago Board Options Exchange; S&P; FQ.

the market's realization of bad news, tends to be reflected in markets rapidly. Bad news may come from an exogenous shock, such as war, surprise attack (e.g., 9/11), coups (e.g., Russian coup in 1991), disease (e.g., SARS, 2002–03), or severe weather. It may come from the distress or failure of a highly leveraged institution (e.g., LTCM), which threatens other institutions and the economy at large. In some cases, destructive forces have been building up for a while out of plain view, but are revealed suddenly, causing a rapid rise in risk aversion.

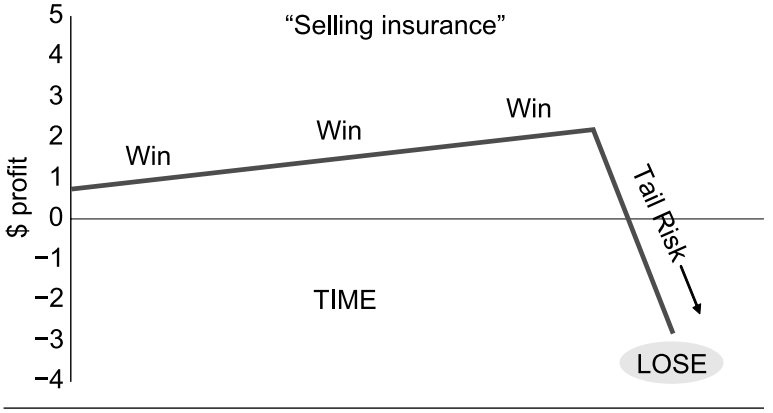
Another reason for the asymmetric reaction is that investors have a greater aversion to losing a given amount than the benefit they perceive from gaining that same amount. Most investors feel good after they gain 40%, but they feel a great deal worse when they lose 40%. Many investors, as soon as they fear loss, flee into low-risk assets and/or seek insurance by, for example, buying options. Investors tend to be more aggressive about avoiding loss than they are about seeking gains. The asymmetry is shown by the connection between changes in the level of risk aversion and returns in the equity market. A rapid increase in risk aversion is more likely to be associated with a sharp market decline than a rapid drop in risk aversion is associated with a sharp market rise.

Because investors are particularly sensitive to how their portfolios perform as risk aversion rises, it is worthwhile understanding how investments perform in different volatility regimes. Volatility can be segmented into three regimes: rising, falling, and constant risk aversion. The following section provides the conceptual basis for how and why investments behave as they do in different volatility regimes. A later section provides empirical support.

Common usage refers to investments that perform poorly as risk aversion rises as "short volatility" because such investments behave, to some extent, as if they were short positions in an index of volatility such as the VIX. As risk aversion rises, the VIX rises and short volatility investments fall. "Long volatility" investments behave in the opposite manner.

A short volatility investment tends to provide positive returns under typical market conditions, but gives up some of its returns when volatility spikes upward. The majority of asset classes are short volatility (see Exhibit 2). Examples include high-yield bonds and strategies that sell options. Both of these investments generate steady income—coupons from high-yield bonds and premium from options—until volatility rises. When volatility rises quickly, high-yield bonds lose value, and options may be exercised on unfavorable terms against the seller. In both cases, the loss in value from the market event may exceed many years worth of coupon or premium income. The equity market is also a short volatility investment. The broad market generates fairly steady earnings and dividends in normal times, although stock prices fluctuate. At the onset of an economic downturn, earnings and stock prices fall sharply.

EXHIBIT 2
What is a Short Volatility Payoff?



The example of selling options highlights the similarity between short volatility strategies and selling insurance. With most kinds of insurance, the seller collects a steady premium until forced to make a payout when an adverse event affects the policyholder.

Most forms of risk premium or beta, and all of those connected with equity, credit, and real estate markets, public as well as private, have short volatility characteristics. This makes sense, since the idea behind a risk premium is to gain a higher return in exchange for accepting systematic risk (as distinct from company-specific risk). When risk aversion rises, the prices of many risky assets fall. Many risk premia are correlated because they rely on healthy economic activity, cash flow and profits. Investors demand that risk premia generate excess returns because they subject investors to additional risk. Investors have a special need for robust returns from their investments when the economy is weak in order to supplement diminished incomes from labor, corporate cash flow, or tax revenues. But this is also precisely the time when most risky assets perform worst. That is one reason why investors demand that risk premia deliver excess returns: they generate returns when investors are less likely to need

them, and the returns evaporate when they are most needed. Investors need to be patient, and to have sufficiently deep pockets, to reap the benefits from risk premium/beta exposure.

There are comparatively few long volatility (see Exhibit 3) asset classes. Bonds issued by governments in the developed markets tend to show moderately positive correlations to changes in risk aversion. Such bonds benefit from a flight to quality. Gold exhibits similar behavior. These assets are viewed as safe havens. A strategy that buys options will be naturally long volatility. Such a strategy is a form of buying insurance. There are few asset classes with a zero correlation to changes in risk aversion. One example is an index of commodity futures.

So far in the discussion about categories of investments we have focused on asset classes—i.e., broad investment groups, many of which could be accessed through passively managed indexed vehicles. It is illuminating to extend the analysis to active investment strategies. The universe of active strategies is vast, and we have confined our analysis here to some widely held alternative investments, including major hedge fund categories, active currency managers, listed private equity, and infrastructure.

There is debate among investors about where the distinction between alpha and beta lies. Some argue that well-known and heavily invested strategies that are easy to implement on a systematic basis are forms of beta rather than alpha. For instance, many consider a static exposure to value or small capitalization stocks to be beta. Going a little further, some also consider the foreign exchange carry trade—a strategy that sells low-yielding currencies and buys high-yielding ones—to be a form of beta. There is a rich discussion on this issue, but here we have taken a pragmatic approach that allows investors to sidestep this question of labeling and focus on how investments perform in the real world. We analyze all investments, beta and alpha, in terms of their behavior as risk aversion rises. In a rising risk environment, some active strategies act very much like conventional betas.

Pure alpha strategies by definition have low correlations to equity and credit markets and other risk premia. They should also have low correlations to changes in volatility, and these strategies are valued for their defensiveness in volatile market environments. It is imperative that prospective investors in a strategy consider both its correlation to other asset classes and its correlation to changes in risk aversion. The latter is crucial for understanding how the strategy is likely to perform in times of market stress.

When analyzing active strategies, investors should be aware of modifications over time to the strategy that could alter its performance during periods of rising risk aversion. This is discussed in the section below. Another consideration is that investors need to know something about the strategy, and it is not enough to know only which instruments may be held in the portfolio. This is because it is possible to replicate short and long volatility behavior using dynamic strategies implemented with instruments that are not inherently short or long volatility.

EMPIRICAL ANALYSIS

We have undertaken analysis on how investments behave in volatility regimes using the VIX, an index that measures the level of volatility that market participants expect the S&P 500 to exhibit over approximately the next month.[3] We divide investments into the three categories suggested above, depending on how they correlate to changes in the VIX:

1. Negative correlation
2. Positive correlation
3. No correlation

Exhibit 4 shows correlations of selected asset classes and active strategies to changes in the VIX. Most hedge fund strategies are short volatility, which is to be expected since most have some exposure to equity or credit betas. Unsurprisingly, short selling is a notable exception, with a strongly long volatility profile. A few strategies have nearly zero correlations

EXHIBIT 3
What is a Long Volatility Payoff?

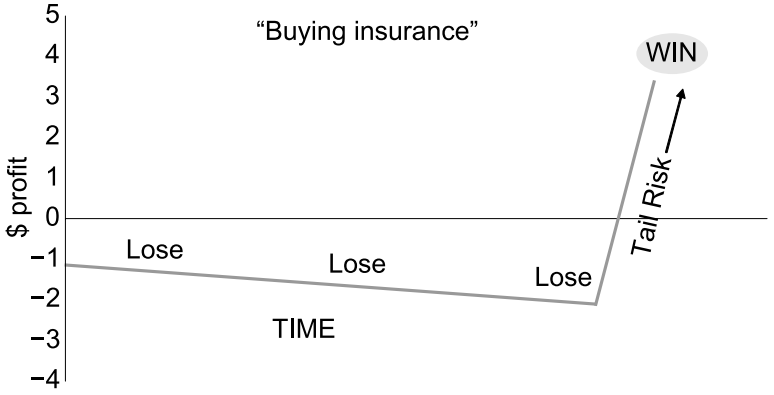


EXHIBIT 4
Do Most Investments Have a Short Volatility Tilt?

	Correlations to Change in VIX (Volatility Index)					T-Statistics	
	Market Stress: S&P −22.0% September 30, 2007, to September 30, 2008	3 Years	5 Years	10 Years	Since January 1990	10 Years	Since January 1990
Short Volatility Tilt							
Sample Plan: 60% Equity, 30% Fixed Income, 10% Alternatives*	−0.85	−0.80	−0.73	−0.72	–	11.39	–
S&P 500	−0.85	−0.81	−0.75	−0.75	−0.67	12.23	13.56
MSCI World Ex-U.S.	−0.82	−0.72	−0.66	−0.66	−0.48	9.48	8.15
MSCI Emerging Markets	−0.68	−0.59	−0.57	−0.62	−0.52	8.88	9.16
HFRI Event-Driven	−0.83	−0.66	−0.63	−0.57	−0.51	7.56	8.82
HFRI Fund of Funds Composite	−0.61	−0.54	−0.53	−0.36	−0.35	4.24	5.56
HFRI Fund Weighted Hedge Fund	−0.66	−0.59	−0.58	−0.54	−0.52	6.91	8.98
HFRI Equity Market Neutral	−0.61	−0.54	−0.56	−0.15	−0.16	1.67	2.36
HFRI Macro	0.13	−0.04	−0.08	−0.06	−0.18	0.62	2.81
HFRI Multi-Strategy	−0.82	−0.71	−0.66	−0.38	−0.38	4.48	6.14
HFRI Merger Arbitrage	−0.81	−0.65	−0.60	−0.48	−0.40	5.87	6.44
Dow Wilshire Real Estate	−0.39	−0.50	−0.39	−0.30	–	3.44	–
S&P Global Infrastructure	−0.75	−0.64	−0.59	–	–	–	–
Merrill Lynch High Yield	−0.93	−0.83	−0.73	−0.50	−0.43	6.23	7.02
HFRI Distressed/Restructuring	−0.73	−0.55	−0.52	−0.40	−0.40	4.70	6.51
HFRI Convertible Arbitrage	−0.85	−0.70	−0.65	−0.41	−0.32	4.81	5.04
S&P Listed Private Equity	−0.65	−0.62	–	–	–	–	–
Long Volatility Tilt							
HFRI Short Bias	0.76	0.72	0.66	0.54	0.49	6.99	8.39
Lehman U.S. Aggregate	−0.27	−0.15	−0.02	0.15	−0.01	1.69	0.09
Citigroup U.S. BIG Treasury	0.37	0.31	0.30	0.35	0.15	4.08	2.21
Citigroup World Ex-U.S. Government	0.08	0.15	0.14	0.11	0.13	1.15	1.89
No/Low Embedded Volatility Tilt							
Citigroup U.S. Inflation Linked	−0.21	−0.06	−0.04	0.17	–	1.85	–
Barclay Currency Traders	0.13	−0.01	−0.09	−0.03	0.06	0.29	0.96
Dow AIG Commodity	−0.27	−0.21	−0.20	−0.11	–	1.23	–

*Note: As of September 30, 2008; *Sample Plan is a hypothetical portfolio used for illustrative purposes only. The plan is composed of 40% U.S. Equities (10% R1000V, 10% R1000G, 10% R2000V, 10% R2000G), 15% MSCI World Ex-U.S., 5% MSCI Emerging Markets Equity, 20% Lehman U.S. Aggregate, 5% Citigroup World Ex-U.S. Govt., 5% Merrill Lynch High Yield, 2.5% Dow Wilshire Real Estate, 2.5% S&P Listed Private Equity, and 5% HFRI Fund of Funds. S&P Listed Private Equity data begins December 31, 2003; a blend of 50% Nasdaq and 50% Russell 2000 was used as a proxy for Private Equity prior to December 31, 2003.*

Source: First Quadrant, LP; HFRI; StyleAdvisor; Bloomberg.

to changes in the VIX over the past 10 years, including convertible arbitrage, equity market neutral, macro, and managed currency. Equity market neutral, however, has been short volatility recently.

Hedge funds of funds and multi-strategy indexes have been consistently moderately short volatility, which is not surprising given the prevalence of equity and credit betas mentioned earlier, and there is a rich academic literature that highlights this issue. The short volatility exposure of both of these indexes has become more pronounced recently.

Understanding why a strategy exhibits short (or long) volatility behavior is instructive. Many strategies do rely on equity and related betas, on liquidity premia or low volatility. One example is a class of strategies called fixed-income convergence trades. These strategies typically sell a relatively low-yielding fixed income instrument and use the proceeds to buy a similar but higher-yielding security. The long position is higher yielding because it is a little less liquid, has a somewhat longer duration, is of slightly lower credit quality, etc., compared to the short position. Fixed-income convergence trades are short volatility because in quiet markets they generate steady income from the yield spread without much change in the relative price of the securities (because the securities are similar), but in a period of rising risk aversion are apt to suffer loss because of a flight to quality. In a flight to quality, investors demand high liquidity, low volatility, and high

creditworthiness, and are prepared to pay for it. The long position has a tendency to underperform the short position. The impact of elevated market volatility on price changes is likely to swamp the gains from the yield spread. The effect is magnified when these positions are applied with leverage, which is often the case because the unlevered yield spreads may be modest.

Another example, the foreign exchange carry trade, is short volatility because it tends to pay off in low-volatility environments. The FX carry trade entails selling currencies associated with low-yielding money market instruments, and buying currencies associated with higher-yielding money market instruments of similar credit quality. In early October, 2008, for example, a typical FX carry portfolio would have long positions in high-yielding Australian and New Zealand dollars and short positions in low-interest-rate Japanese yen and Swiss francs. When currency markets are stable, the strategy earns the yield spread, but when volatility rises, there is often a retreat to "safer" currencies, which tend to have lower yields. Again, elevated market volatility swamps the return from the yield spread.

The sensitivity of an asset class to changing risk aversion tends to be fairly consistent over time, at least in terms of the direction. An asset class that is short volatility is likely to act that way over most periods, because it is a fundamental aspect of its behavior. Active strategies, however, may vary over time depending on how dynamic the underlying strategy is. If the strategy includes rotation between a long and a short position in a risk premium, then its behavior when risk aversion is rising will depend on whether it is long or short. It is most important that investors understand this aspect of a strategy. They should request sufficient data from managers on the strategies under consideration to enable them to do the analysis. One hurdle is that investors need strategy returns that include, ideally, a few crisis periods. Since we are in the midst of a crisis right now, this presents less of a difficulty. Investment managers with systematic approaches can help to overcome this hurdle with performance simulations. While simulations should be regarded with a degree of skepticism, they may nevertheless provide insight.

Earlier, we mentioned an example of a strategy where the pattern of returns in relation to rising risk aversion has changed over time: equity market neutral. On average over the past 10 years, the returns of this strategy had low correlations to changes in the VIX, but more recently the strategy has performed poorly during rising risk aversion. We don't know conclusively why this change in behavior occurred because we don't know the underlying holdings in the portfolios that constitute the index. We can venture to make an educated guess, however. In the case of equity market neutral, many managers had emphasized value stocks and small-capitalization stocks because they had been performing well for several years prior to the middle of 2007. It has been suggested that when the subprime financial crisis erupted in the summer of 2007, the following events occurred: some multi-strategy hedge funds and investment bank proprietary trading desks, suffering large losses on securities linked to subprime loans, were forced to liquidate rapidly other parts of their portfolios, including equity holdings that were heavily represented by formerly high-flying value and small-cap stocks. Value and small-cap stocks underperformed at the same time that risk aversion spiked in equity and credit markets. We believe that the recent short volatility behavior of equity market neutral was a temporary phenomenon caused by an unusual demand for liquidity. We expect this strategy to revert to its more usual volatility-neutral pattern.

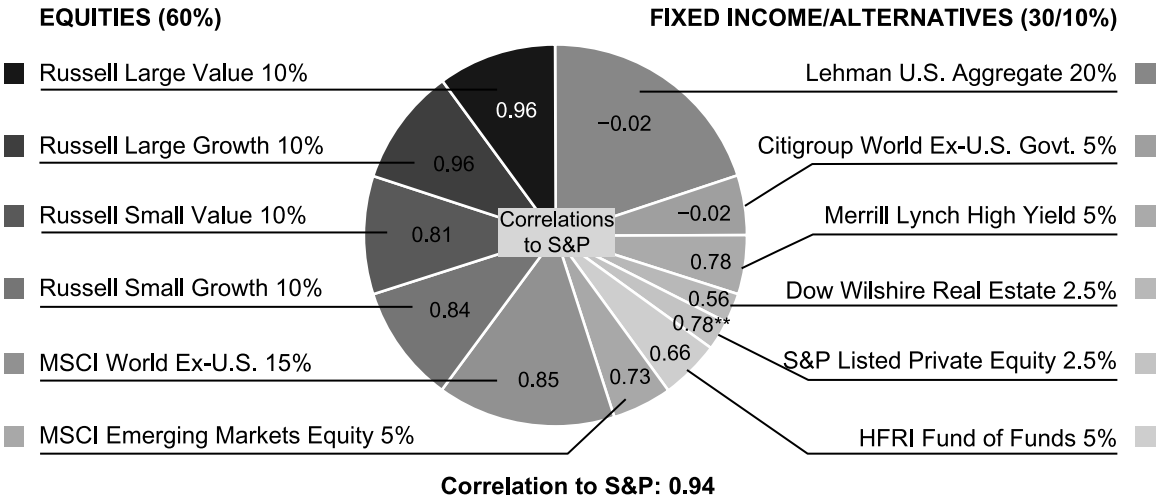
IMPLICATIONS FOR ASSET ALLOCATION

Having laid the groundwork by examining individual asset classes and alternative investment strategies, we look at the implications for asset allocation. A typical defined benefit (DB) pension plan develops its asset allocation using an iterative process that compares the valuation of liabilities with the valuation of assets. Different asset mixes are tested in a variety of market scenarios. A key consideration is the tradeoff between the average level of required contributions to the plan versus the volatility of contributions, assuming prudent and regulated levels of funding. Asset mixes with higher expected returns are usually riskier on a stand-alone basis, and are generally associated with more variable, yet on average lower, contributions. This process is called asset-liability modeling (ALM). A thorough approach to ALM incorporates one or more financial crises into the market scenarios that are modeled.

We have analyzed a sample asset mix of 60% equities, 30% fixed income, and 10% alternatives, as shown in Exhibit 5. A fairly traditional mix, it has a heavy weight to equities, and 5% from the fixed-income allocation is in high-yield bonds and the alternative assets are in real estate and private equity, all of which exhibit equity-like behavior. The weighted average correlation of this portfolio to the S&P 500 is a high 0.94, reflecting the weight

EXHIBIT 5

One View of Diversification. Sample Investment Plan Asset Allocation*. Correlations to S&P 500 Index—Five Years Ending September 30, 2008



*Note: *Sample Plan is a hypothetical portfolio used for illustrative purposes only. The plan is composed of 40% U.S. Equities (10% R1000V, 10% R1000G, 10% R2000V, 10% R2000G), 15% MSCI World Ex-U.S., 5% MSCI Emerging Markets Equity, 20% Lehman U.S. Aggregate, 5% Citigroup World Ex-U.S. Govt., 5% Merrill Lynch High Yield, 2.5% Dow Wilshire Real Estate, 2.5% S&P Listed Private Equity, and 5% HFRI Fund of Funds; **S&P Listed Private Equity data begins December 31, 2003; a blend of 50% Nasdaq and 50% Russell 2000 was used as a proxy for Private Equity prior to December 31, 2003.*

Source: First Quadrant, LP; StyleAdvisor; Bloomberg.

to risky assets and the much greater volatility of risky assets compared to the low-correlation high quality bonds that make up 25% of the weight.

Another way to view this portfolio is from the volatility perspective, as shown in Exhibit 6. The portfolio as a whole has a pronounced short volatility tilt, so we know that it is likely to perform poorly when risk aversion rises—consistent with the heavy weight in equities and related assets. While the example above is for a DB pension plan, the implications for asset allocation, set forth below, apply to most types of investors, including defined contribution plans, endowments, foundations, sovereign wealth funds, and so forth.

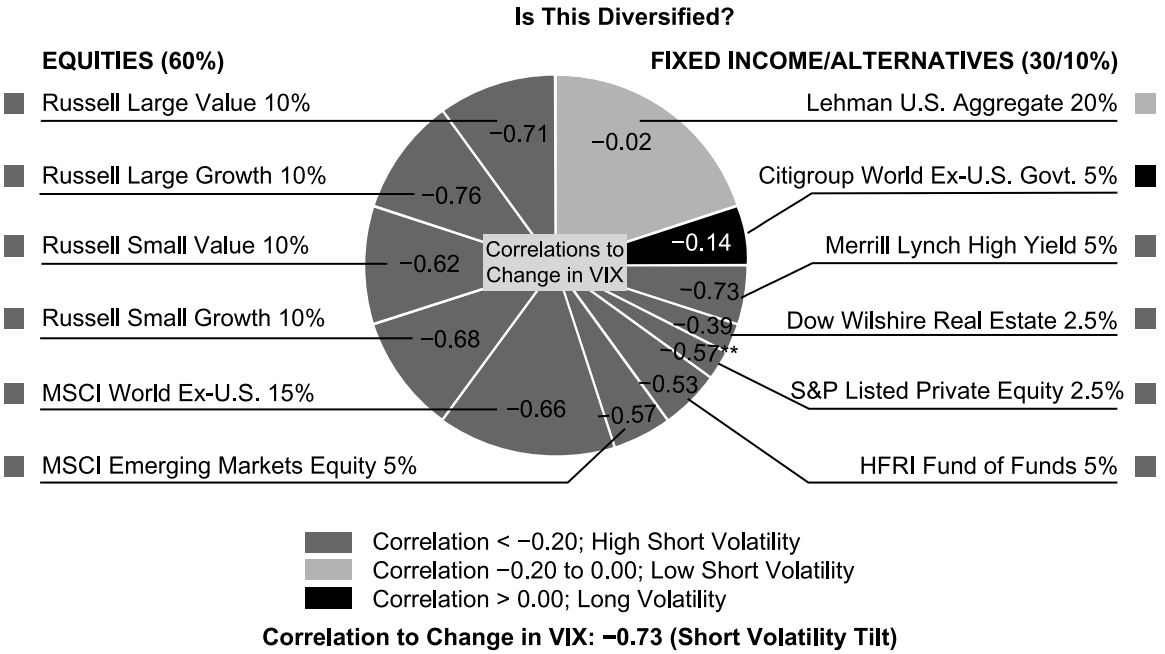
Although this portfolio has a typical level of diversification for a traditional plan, its return profile is similar to an all-stock portfolio. If holders of this hypothetical portfolio wished to improve its performance in a period of rising risk aversion, they have several choices. The challenge is to do so without sacrificing too much of the expected return. Increasing the allocation to high-quality long-term bonds would improve independence from the stock market but at substantial cost to future returns. If investors are willing to apply a degree of leverage to high-quality bonds, they can augment returns. Another approach is to seek low correlations from active strategies—pure alpha—rather than from risk premium-heavy asset class exposure. Increasing the allocation to active strategies with positive or low correlations to changes in the VIX would improve the portfolio's resilience to market crises. For this approach to work, investors need to have access to sources of alpha that they have confidence in.

Earlier in this section we mentioned how a typical DB pension plan develops its asset mix. The ALM framework must be used with particular care if active strategies form a significant portion of the portfolio's risk budget. The reason is that the behavior of active strategies needs to be accurately reflected, especially in crisis periods. This may be difficult, though not impossible, if the strategies do not have much performance history. If, for example, hedge fund of funds are part of the mix, then the meaningful correlation to equities and short volatility exposure should be captured. Investors would get misleading reassurance if they model short volatility assets as non-correlated.

Investors sometimes use mean-variance optimizers to ensure that their asset mix is "efficient" in the sense

EXHIBIT 6

A Different View of Diversification. Sample Investment Plan Asset Allocation*. Correlations to Change in VIX—Five Years Ending September 30, 2008



*Note: *Sample Plan is a hypothetical portfolio used for illustrative purposes only. The plan is composed of 40% U.S. Equities (10% R1000V, 10% R1000G, 10% R2000V, 10% R2000G), 15% MSCI World Ex-U.S., 5% MSCI Emerging Markets Equity, 20% Lehman U.S. Aggregate, 5% Citigroup World Ex-U.S. Govt., 5% Merrill Lynch High Yield, 2.5% Dow Wilshire Real Estate, 2.5% S&P Listed Private Equity, and 5% HFRI Fund of Funds; **S&P Listed Private Equity data begins December 31, 2003; a blend of 50% Nasdaq and 50% Russell 2000 was used as a proxy for Private Equity prior to December 31, 2003.*

Source: First Quadrant, LP; StyleAdvisor; Bloomberg.

that it offers the highest expected return for its level of volatility. They want the portfolios tested in the ALM framework to be mean-variance efficient, or close to it. For some kinds of investments, however, mean-variance analysis is an inadequate tool for properly assessing risk because the investment's return distribution is very different from the familiar bell-shaped curve of a normal distribution. Investments with pronounced short or long volatility exposure may have highly non-normal distributions. Failing to take into account an investment's fat negative tail would cause investors to underestimate risk in a market crisis. If those risks are important, then investors should use additional tools to improve their understanding of the portfolio's behavior. Future research will cover these concerns more fully.

CONCLUSION

The purpose of this article has been to review investment diversification during periods of rising risk aversion. We show how changes in the VIX are a useful way of categorizing investments. Most forms of risk premium underperform as risk aversion rises—a perfectly natural retreat from the threat of economic and corporate weakness. The performance of active strategies in rising risk aversion presents a mixed picture. Some strategies are just as exposed as, for example, equities, while others hold up fairly well. It is vitally important that investors undertake the analysis needed to understand how their portfolio and each of its component parts perform in bad times as well as good. Regardless of the amount of risk investors are prepared to take, they do not want to be taken by surprise.

ENDNOTES

[1]For a sampling of literature that provides insight on how investments behave in periods of rising risk aversion, see Weisman [2002], Agarwal and Naik [2004], and Anson and Ho [2003].

[2]We chose S&P 500 volatility as the basis for analysis because the S&P 500 is representative of markets globally, it is convenient to look at a single market, and the U.S. equity market has a long history of index options. While the ideal indicator of market risk aversion would combine data from equity and credit markets globally, and from other markets as well, our analysis shows that the VIX does a good job of capturing the effects we seek to measure. Another question worth asking is why we look at changes in expectations for volatility, VIX, rather than observed S&P 500 volatility. The answer is that while much of the time we would get similar results, the VIX does a better job of capturing market concerns about extreme events—the events at the negative tail of the return distribution. Investors with exposure to the U.S. equity market can buy put options on the S&P 500 to protect themselves. The amount that they are willing to pay—reflected in the VIX—tells us something about the probability they assign to an extreme negative outcome. Also, because the VIX is forward-looking, it is quicker to reflect investor's concerns about risk.

[3]The VIX is calculated using volatility that is implied in the prices of traded put and call options. See the VIX whitepaper published by the CBOE for further details.

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