

Quantitative Portfolio Strategy

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QUANTITATIVE PORTFOLIO STRATEGIES: LESSONS AND PROSPECTS

Throughout 2002, the Quantitative Portfolio Strategies Group had the pleasure of working with many investors seeking new tools and analyses to cope with the turbulent markets and to position their portfolios for stronger performance next year. As a result of our interactions, we have garnered some insight into what is on investors' minds. While we share results of studies only with the investors who request them, we thought we would share with readers some of the more general themes that we encountered repeatedly from numerous investors, as well as their broad portfolio management implications.

1) Ongoing Consideration and Adoption of Customized Benchmarks

The volatile fixed-income markets have given many investors another reason to appreciate the value of a performance benchmark. For senior management and plan sponsors, knowing that their manager is measured against a specific benchmark removes some of the uncertainty about how the portfolio should be performing. The volatile market environment has also highlighted the importance of the benchmark choice. Many portfolio managers contacted us during the year for help in identifying and justifying an appropriate benchmark. If a standard Lehman index was not appropriate, then we were able to construct a custom benchmark.

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Many investor inquiries concern two types of custom benchmarks: short-duration or floating-rate benchmarks and issuer-capped benchmarks (discussed later). Short-duration and floating-rate assets are an area of the marketplace that has not received a lot of Lehman index coverage. The reason for the lack of coverage is that there was little demand for standard short-duration benchmarks, as many financial institutions and plans managed short-duration portfolios (e.g., less than two years) in-house and often compared their efficacy with a generic yardstick such as a LIBOR rate. These portfolios generally contain an assortment of short assets: ABS, structured product, MBS, and highly rated short corporates. Many of these portfolios have never had a benchmark, or if they did, the benchmark (e.g., short Treasuries or LIBOR) did not represent the assets in the portfolio. In recent years, with the emphasis on quantifying performance and value-added compensation schemes, institutions have sought to benchmark these short-duration portfolios. The challenge is to design a benchmark with a short duration that also reflects the normal allocation to the various asset classes.

The same applies to floating-rate portfolio managers. We received numerous inquiries from floating-rate portfolio managers indicating that their management would like them to be measured relative to a benchmark. For many of these portfolios, there are no standard Lehman floating-rate indices at present (although, as covered in the Index section of this edition of GRV, we are planning to introduce U.S. dollar and euro-denominated floater indices in 2003). Floating-rate managers are expected to hold a range of assets (e.g., MBS, corporates, CMBS, and ABS) of various credit qualities. These managers often buy floating-rate product using asset swaps (i.e., buying fixed-rate spread assets and swapping them to floating rate). An ideal benchmark design for these managers is a floating-rate benchmark that reflects neutral spread sector exposures. For example, suppose a floating-rate portfolio manager is normally 30% weighted in ABS, 30% in MBS, 10% in CMBS, and 30% in A-rated corporates. In general, LIBOR is an inappropriate benchmark, because the floating portfolios contain exposures to credit spread risk and prepayment risk. The idea is to create a custom floating index that reflects

the manager's asset allocation. We have detailed a method for constructing floating-rate benchmarks for such portfolios that has been adopted by several investors.¹

Some investors are also re-evaluating the appropriateness of a traditional total return benchmark.

Some investors are also re-evaluating the appropriateness of a traditional total return benchmark. These investment managers generally operate under many more constraints than simply maximizing total return. For example, some of these managers are not allowed to sell assets unless called upon to do so for reasons found elsewhere within the organization. For these managers, a total return benchmark is too simplistic, too far removed from their objectives, and more than likely, very frustrating. As a result, some managers have asked us to design alternatives to total return benchmarks. For example, a "yield" benchmark might be more appropriate as it can measure how well the manager can add assets with better return potential. Given the great improvement in index technology that can make such "non-standard" benchmarks possible, we anticipate many more such inquiries during the course of 2003.

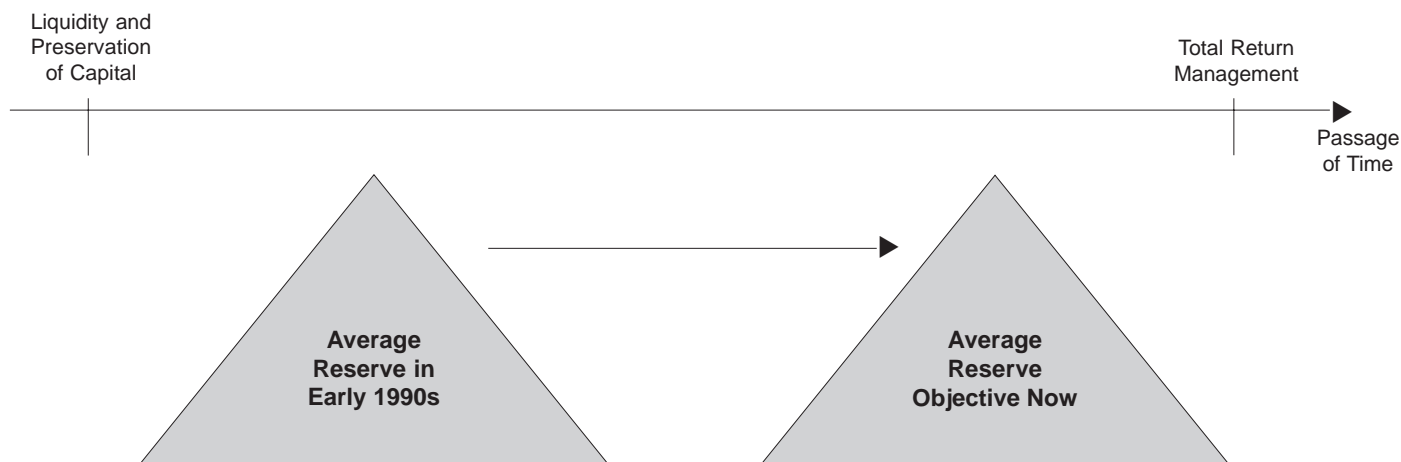
However, with liquidity provided by the European Central Bank and a reduced emphasis on quick and massive currency interventions, many central banks have moved closer to a total return management approach including investment in less-liquid spread assets and active trading strategies.

2) Central Banks Continue Moving toward Total Return Management

Throughout 2002, many central banks and other official institutions continued their evaluation of switching from a Treasury buy-and-hold approach to more of a total return aggregate benchmark approach. Official reserve managers have always tried to balance the need to maximize returns while at the same time maximizing liquidity. However, with liquidity provided by the European Central Bank and a reduced emphasis on quick and massive currency interventions, many central banks have moved closer to a total return management approach including investment in less-liquid spread assets and active trading strategies. Figure 1 presents a schematic of this change in management style for official reserves portfolios.

¹ *The Lehman Brothers Swap Indices*, January 2002, and *Benchmarks for Asset-Swapped Portfolios*, Lehman Brothers, February 2002.

Figure 1. How the Reserve Objective of Central Banks Has Changed over Time



We feel, however, that this switch will be gradual and is unlikely to produce an abrupt re-pricing in the market for spread assets.

There are several factors explaining the growing interest in broader aggregate-type benchmarks for official reserves: the likely increase in supply of U.S. Treasuries during the middle of this decade, the relative attractiveness of high-quality spread product, the emergence of the euro credit market, and the gradual reduction in gold reserves. This switch by central banks from a governments-only benchmark to an “aggregate”-style benchmark is currently under way. We feel, however, that this switch will be gradual and is unlikely to produce an abrupt re-pricing in the market for spread assets.

The asset class receiving the most attention recently is U.S. MBS.

Many central banks have long allowed investing in U.S. agency securities and highly rated sovereigns. More recently, these institutions have begun to consider investing in AAA-rated MBS and ABS securities. The asset class receiving the most attention recently is U.S. MBS. MBS offer several attractive attributes: relatively little idiosyncratic “name” risk, an Aaa-rating, and excellent liquidity. Of equal importance, the management of a passive mortgage portfolio is relatively easy (discussed below), allowing the institution to add the asset class to the portfolio without having detailed mortgage market knowledge or operational capability.

Another asset class on the horizon for central banks as an investment (not a hedging) vehicle is interest-rate swaps.

Another asset class on the horizon for central banks as an investment (not a hedging) vehicle is interest-rate swaps. Swaps offer tremendous liquidity, limited “headline” risk, and an opportunity for central banks to capture some of the spread in non-Treasury product.

In addition to including spread product in their portfolios, we see central banks considering risk-controlled quantitative trading techniques to enhance portfolio returns.

In addition to including spread product in their portfolios, we see central banks considering risk-controlled quantitative trading techniques to enhance portfolio returns. Several years ago, we developed the “No-View” Optimization strategy for U.S. Treasury portfolios, which imposes a minimum return requirement (e.g., zero) but allows the portfolio’s duration to change in response to market conditions to maximize risk-adjusted expected returns. This strategy has performed well and has attracted some additional participants during the year. Given the growing involvement of central banks in spread sectors and consideration of more active trading strategies, we fully expect official institutions to become even more important participants in the global debt markets.²

One key attraction of the Global Aggregate as a benchmark is that it offers investment managers the opportunity to search for alpha in a wider array of markets: multiple currencies, benchmark curves, and sectors.

3) Continued Rapid Growth of Global Aggregate Portfolios

The Global Aggregate Index remains Lehman’s fastest growing benchmark (in terms of managed assets). At year-end 2002, we estimate that over \$350 billion is benchmarked against the Global Aggregate. One key attraction of the Global Aggregate as a benchmark is that it offers investment managers the opportunity to search for alpha in a wider array of markets: multiple currencies, benchmark curves, and sectors. However, managing against the Global Aggregate presents many challenges. For example, how should the investment management firm be organized—by geographic region or by sector? What should the manager do if the Global Aggregate contains asset classes with which he is unfamiliar (e.g., U.S. MBS)? Also, how can a manager quantify the risk of a portfolio versus the benchmark—should regional risk models be aggregated or is a global risk

² Total Return Management of Central Bank Reserves, Lehman Brothers, June 2002.

model required? Given the rapid growth of the Global Aggregate, it is not surprising that a large portion of our inquiry from portfolio managers revolves around managing against the Global Aggregate.

For non-U.S. investors, the first complication to managing against the Global Aggregate Index is the 17% allocation to U.S. MBS, which is an asset class with which they and their operations are often unfamiliar. While MBS (unlike corporates) have little idiosyncratic risk, they are exposed to prepayment and volatility risk. However, exposure to these risks makes the presence of MBS in the Global Aggregate advantageous due to the low correlation of these risks to the risks of the government and credit components of the index. As a result, the presence of MBS has a variance-reducing effect on the overall index that improves its risk-adjusted return potential. Unfortunately, these benefits come with a price. The management of a MBS portfolio is a highly technical task due to the uncertain monthly mortgage cash flows and the need for a prepayment model to guide relative value decisions. In addition, while the index (*i.e.*, the investor's benchmark) is composed of annual "generics," investors must purchase individual pools. The pool selection process requires additional hands-on MBS market experience that many non-U.S. asset managers have not had the opportunity to develop.

To enable non-U.S. investors to compete effectively for Global Aggregate mandates, including the MBS asset class, we developed a method for replicating the MBS portion of the index.

To enable non-U.S. investors to compete effectively for Global Aggregate mandates, including the MBS asset class, we developed a method³ for replicating the MBS portion of the index. For many investors, replication is a natural initial strategy that lets them match the benchmark while gradually acquiring the experience necessary for more active management. The replication strategy is simple and produces a relatively low tracking error versus the MBS component of about 19 bp per year. Over the course of 2002, several European investors chose this MBS replication technique, which helped them compete successfully for Global Aggregate mandates. We now have eighteen months of actual performance numbers for this replication strategy that we would be pleased to discuss with interested investors.

Strategies for Managing a Global Aggregate Portfolio

Once the manager wins a Global Aggregate mandate, a key question naturally arises: what types of investment strategies are likely to offer the best potential to outperform the Global Aggregate? To address this often-heard question, we carried out a study using our "imperfect foresight" approach to compare the risk-adjusted returns of various global strategies at different skill levels.⁴ We start with traditional global strategies such as the timing of exposures to global duration, regional duration, curve twist in various currencies, and fx. In addition, we include strategies that allocate to investment-grade credit, high yield, emerging market debt, and inflation-protected securities. Our study illustrates the use of risk budgeting to target the risk profile of a portfolio using an *ex-ante* risk model.

³ *Tradable Proxy Portfolios for the Lehman Brothers MBS Index*, Lehman Brothers, July 2001.

⁴ *Value of Skill in Macro Strategies for Global Fixed Income Investing*, forthcoming.

In general, our study confirms the general principle that as long as each strategy is implemented in a similar way (with the same number of degrees of freedom), different strategies executed at the same skill level should produce roughly the same information ratio. However, portfolio constraints can often reduce the efficiency with which a skilled manager's views can be converted into outperformance. We measure the drag on performance caused by two common constraints: no short positions in certain asset classes (e.g., high yield and emerging markets) and no use of leverage to implement pure duration views.

Diversification among several strategies is the key to increasing overall performance, but correlations among strategies (and among analysts' views) reduce the benefits of such diversification.

Diversification among several strategies is the key to increasing overall performance, but correlations among strategies (and among analysts' views) reduce the benefits of such diversification. We examine the correlations among the strategies studied to help identify effective combinations. Some pairs of strategies had correlations that changed radically over time; we sought pairs of strategies that had low correlations both before and after European Monetary Union on January 1, 1999. We found, for example, that the global duration strategy (long duration in five currencies) has a consistently low correlation (0.08) with a global curve twist strategy (steepeners in 3 currencies). A USD versus EUR yield spread strategy (long USD duration, short EUR duration) was positively correlated (0.56) with the global duration strategy, but had consistently low correlations with a USD curve steepener (0.08) and with an emerging market strategy (0.04). Foreign exchange strategies also offered good opportunities for diversification of risk. A strategy that goes long JPY fx exposure had low correlation (0.06) with the global duration strategy.

Are Credit Markets Globally Integrated?

A Global Aggregate benchmark includes bonds from the same issuer in different currencies. A key issue for managing a Global Aggregate portfolio is the correlation of cross-currency spread movements. Are the spreads of a given issuer highly correlated across currency markets, indicating that returns for the issuer are affected mostly by global factors, or is there low correlation of spread movements, indicating that regional risk factors are more important? This question has important ramifications both for the organizational structure of the investment management firm and also for risk management.

Recently, portfolio managers have asked us to analyze the cross-currency correlation of spreads. In response, we conducted an in-depth empirical study⁵ of spread performance in the Global Aggregate Index focusing on the four major currencies over the past 44 months. We measured cross-currency correlation of LIBOR spread changes for individual issuers, as well as for sectors and credit qualities.

Our analysis indicates that as credit quality drops and spreads increase, spread correlation rises.

Figure 2 presents the EUR-USD results at the issuer level. Our analysis indicates that as credit quality drops and spreads increase, spread correlation rises. In the case of EUR-USD issuer spread, an R^2 of 0.65 implies a high level of explanatory power of the LIBOR spread level with respect to correlation. With a t-statistic of 5.5, the spread level is a significant factor in explaining correlation levels.

⁵ Are Credit Markets Globally Integrated? An Initial Assessment, Lehman Brothers, December 2002.

Bonds denominated in yen appear to be uncorrelated with their counterparts in the other three currencies, possibly due to the presence of withholding tax, a more regional investor base, and less active secondary market trading that may segment the yen credit market from the rest of the world.

Figure 3 presents correlation results at the sector level. There is evidence that the sector itself is a significant factor in explaining correlation, even after taking into account the relative spread levels of different sectors. In addition, bonds denominated in yen appear to be uncorrelated with their counterparts in the other three currencies, possibly due to the presence of withholding tax, a more regional investor base, and less active secondary market trading that may segment the yen credit market from the rest of the world.

These findings have several implications for investors managing against the Global Aggregate Index. In dealing with risk management, the results show the need for accounting of issuer-specific risk on a global basis. This is important to investment management firms that apportion credit management to regional teams in the U.S., Europe, and Asia. If each local credit portfolio management team chooses the same high-spread names for its part of the overall portfolio, it will be increasing the portfolio's overall risk exposure compared with a coordinated strategy whereby different high-spread names are held in different currencies. For low-spread instruments with stable and high credit quality, typically agency or supranational paper, the

Figure 2. **EUR-USD Issuer Correlations**

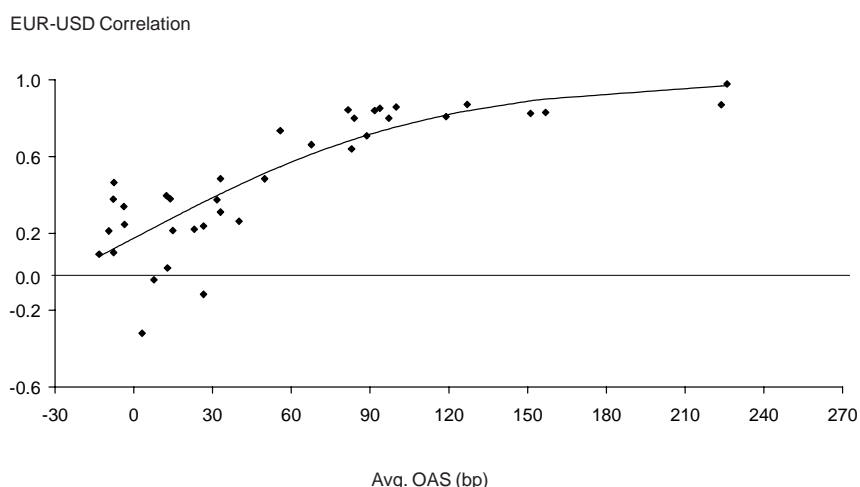


Figure 3. **Sector Level Correlation Results**

	Quality	# Issues in Universe				Avg. OAS	Correlation Estimate					
		EUR	GBP	JPY	USD		EUR-GBP	EUR-JPY	EUR-USD	GBP-JPY	GBP-USD	JPY-USD
Supra-National	Aaa	33	27	8	76	-10	0.03	0.21	0.29	-0.07	0.12	0.13
Agencies	Aa1	138	15	219	169	-2	0.15	0.20	0.13	-0.21	0.10	-0.01
Local Govt.	Aa2	121	6	95	42	7	NM	0.42	0.34	NM	NM	0.06
Finance	Aa3	293	37	249	436	36	0.28	0.11	0.61	0.08	0.53	-0.02
Sovereign	A2	35	3	32	102	43	NM	0.04	0.58	NM	NM	-0.11
Utilities	A1	54	9	98	101	71	0.27	0.04	0.87	0.05	0.20	0.06
Industrial	A3	239	26	90	534	77	0.59	-0.27	0.84	-0.24	0.73	-0.15

cross-currency issuer correlation is low. So holding the same issuer in different currencies provides increased diversification.

Furthermore, the analysis indicates that when it really matters most (*i.e.*, when risk is high), correlations are also high. Therefore, if portfolio managers match the issuer level exposure of a benchmark, they are probably not exposed to a great deal of idiosyncratic risk, even if at the issue and currency level allocation is quite different. When correlations are low, however, they may be exposed to risk, but it will be of relatively small magnitude.

We find that global credit benchmarks make more sense as we cover the lower end of the credit spectrum, where the need for diversification is more acute.

Concerning benchmark decisions, we find that global credit benchmarks make more sense as we cover the lower end of the credit spectrum, where the need for diversification is more acute. Our study indicates that diversification in terms of currency of denomination will reduce issuer-specific risk in low-spread names but not for high-spread issuers, for which the cross-currency correlations are typically high. For high-spread issuers, issuer-specific diversification has to be achieved through a broadening of the set of names from which the portfolio is selected rather than adding positions of the same issuer in different currencies.

Our study also suggests that a strategy of representing Japanese institutional debt issued in yen by the corresponding debt in euro, U.S. dollar, or sterling may not perform well due to low cross-currency correlations. However, international investors holding diversified portfolios of euroyen issues from supranational, agency, or sovereign borrowers (thereby avoiding the withholding tax) have been able to capture the performance of the yen yield curve with little spread risk, given the low historical spread volatility and low correlation of spread movements.

Our global risk model will cover investment-grade assets worldwide and, therefore, include risk factors related to currency exposure, as well as local investment-grade markets.

Moving toward a Global Risk Model in 2003

The results of the spread correlation study have implications for one of our major efforts planned for 2003 and beyond. The rapid growth of assets benchmarked to the Global Aggregate Index has prompted us to develop a Global Aggregate risk model during 2003. The purpose of a risk model is to explain the *ex-ante* level of risk—either absolute or relative to a benchmark—as the result of, first, exposures to a limited set of systematic risk factors and, second, exposures to individual issues or issuers. Our global risk model will cover investment-grade assets worldwide and, therefore, include risk factors related to currency exposure, as well as local investment-grade markets.

We have been discussing the construction of the global risk model with investors. As our readers know, the U.S. Aggregate Risk Model,⁶ the Euro-Aggregate Risk Model, and the JGB Risk Model are well-established tools in the management of both active and passive regional portfolios versus Lehman index benchmarks. How should we approach construction of a global risk model? In particular, we are grappling with the issue of which risk factors are global and which are regional. To the extent that risk factors are regional, global managers can use the regional risk models to manage overall portfolio risk versus

⁶ A new version of Lehman's U.S. Aggregate Risk Model was released in 2002. The new model includes more robust handling of term structure (using key rate durations), volatility (using vegas), and credit risk. In addition, the new model allows time-varying handling of risk factor estimation and now covers both ABS and CMBS. See Section 4 for more details.

the Global Aggregate benchmark. However, to the extent that risk factors are global, then a global risk model would allow managers to get a more accurate measure of his portfolio risk. The above spread correlation study seems to indicate that some global credit risk factors are at work.

Another issue we are discussing with market participants is the issue of the reference curve. European investors are comfortable with the swap curve as their reference curve for all of their markets. As a result, for the Euro-Aggregate Risk Model, we model credit-spread risk as the spread to swaps. In the U.S., on the other hand, while MBS, ABS, and CMBS investors are comfortable using the swap curve as the reference curve, corporate investors continue to use U.S. Treasuries. A couple of years ago, it appeared that corporate investors might switch to the swap curve, as the correlation of swap and credit spreads remained quite high. However, in the fall of 2001, the correlation weakened and has remained relatively low during 2002.⁷ For the U.S. Aggregate Risk Model, we model credit, MBS, ABS, and CMBS spread risk as the spread to Treasuries. How shall we move forward on the Global Aggregate Risk Model? If we maintain the current specification, we would not be able to calculate consistently the portfolio's risk exposure to various credit risk factors. If, instead, we modeled U.S. corporate spreads to the swap curve, then the resulting factor variance-covariance matrix would not conform to the intuition that U.S. corporate investors have developed over many years. In addition, the variance-covariance matrix of excess returns to swaps could be very different from the matrix of excess returns to Treasuries. As a result, asset allocations could change dramatically. There are good arguments on both sides of the benchmark debate. As always, we would like to hear from investors who have a view on this issue.

We anticipate significant interest in the global risk model. Fund managers running mandates versus multi-currency indices will use it to construct replicating portfolios or to monitor the risk of active views in their portfolios. Investors will be able to budget active risk across different risk dimensions related, for example, to currency allocation, overall and cross-market yield curve risk, allocation across spread sector, or name-specific strategies. As risk model analytics continue to enrich our portfolio analytics platform, we will be able to define scenarios that reflect interdependence among risk factors and provide investors with the ability to perform optimization of global portfolios, including their specific views and constraints.

4) Managing Credit in a High Risk/High Potential Return Environment

Needless to say, the big fixed-income story in 2002 was the explosion in idiosyncratic credit risk—the so-called credit torpedoes that wrenched investor portfolios. Not unexpectedly, the tremendous spread volatility was accompanied by serious liquidity problems. Unlike many previous periods of credit turmoil, usually involving smaller and lower-quality names, this time, some of the largest issuers were in the center of the storm. The Quantitative Portfolio Strategies Group spent much of this year working with credit investors. Our interaction with portfolio managers produced several studies and new approaches to managing credit in this environment.

⁷ For up-to-date swap-credit spread correlations, please refer to our web site at www.LehmanLive.com

The seeking of alpha through active name selection became a highly risky activity. For many investors, the risk far exceeded any possible reward.

Diversifying credit risk presents its own challenges. While it is clear that event risk is higher in lower qualities, the optimal levels of diversification are less obvious. The costs of excessive diversification must also be considered.

The clear conclusion is to diversify more in the lower credit qualities.

For the optimized high-yield portfolio, the recommended position ratio was found to be 5:2:1 (Caa/C:Ba:B), which is less skewed than the corresponding 10:3:1 ratio for the optimized investment-grade portfolio when only downgrade risk is considered.

The increased headline risk forced credit managers to reconsider their approaches to managing risk and structuring their portfolios. The seeking of alpha through active name selection became a highly risky activity. For many investors, the risk far exceeded any possible reward. As a result, investors shifted their efforts to broader asset allocation decisions and adopted a more disciplined approach to diversifying security-specific risk. As we discuss below, this shift also caused changes in benchmark requirements, the formulation of investment policies, and the design of analytical tools.

Optimal Diversification Levels

Diversifying credit risk presents its own challenges. While it is clear that event risk is higher in lower qualities, the optimal levels of diversification are less obvious. The costs of excessive diversification must also be considered. Increased transaction costs, as well as the increased cost and dilution of credit research, put constraints on the degree of diversification. We address these issues in our study of sufficient diversification in credit portfolios that concentrated on the risk of downgrade in investment-grade portfolios. We develop a simple model of downgrade risk based on the observed historical underperformance of downgraded bonds and transition probabilities published by rating agencies. To minimize tracking error due to downgrade risk, the model recommends uneven diversification in various credit ratings. When we first published the study using data through the end of 2000, the optimal position size in Aaa/Aa-rated bonds was nine times that of bonds rated Baa. The optimal position size in A-rated bond was four times that of a Baa. In early 2002, we extended the study to include the experience of 2001.⁸ Not surprisingly, the recommended diversification levels have become even more skewed, with the ratio of optimal position sizes at 10:3:1. While investors may not precisely follow these rather dramatic ratios, the clear conclusion is to diversify more in the lower credit qualities. To arrive at more realistic position size ratios, we took into account the volatility of spreads not caused by rating transitions ("natural" volatility). Indeed, this type of volatility dominates in the high-quality segment of the market. As a result, the inclusion of the natural volatility mitigates to some extent the differences in the optimal diversification levels. The recommended position size ratio was found to be 4:3:1 in the 2001 study. The extension to 2002 made this ratio more skewed as well, at 5:3:1. These levels are accepted by most portfolio managers as realistic. We have worked with many investors who have implemented the conclusions of this study and have constructed benchmarks that demand different levels of diversification in different credit qualities.

Unlike the investment-grade market, in which downgrades almost never lead straight to default, this happens frequently in the high-yield market. We took this into account as we searched for the optimal position sizes in the high-yield market. As in the investment-grade market, we found that the loss magnitude increases as the downgrade approaches, culminating in the three months before the downgrade. As expected, both the magnitude and the volatility of loss increase sharply for lower qualities. In all cases, the standard deviation of loss far exceeds the mean, highlighting that underperformance of individual bonds relative to their peers can be truly devastating. For our study of the high-yield market, we limited ourselves to studying only the downgrade risk, not accounting for the

⁸ Sufficient Diversification in Credit Portfolios, Lehman Brothers, May 2002.

natural spread volatility caused by other factors. For the optimized high-yield portfolio, the recommended position ratio was found to be 5:2:1 (Caa/C:Ba:B), which is less skewed than the corresponding 10:3:1 ratio for the optimized investment-grade portfolio when only downgrade risk is considered.

In general, the selection of appropriate relative weights of various maturity TRAINS® is an efficient way to achieve the desired term structure exposure while matching the sector and quality distribution of a credit benchmark.

Diversified Credit Baskets

Investors' demand for diversification was met by supply in the form of a new type of credit instrument—a basket of liquid corporate bonds traded as one security. Lehman Brothers launched “targeted return index securities,” or TRAINS®, in both the U.S. dollar and euro markets. The \$-TRAINS® contain about 25 corporate bonds having a minimum outstanding amount of \$1 billion. The weights of the individual securities in the TRAINS® basket are designed to minimize the tracking error against a corresponding maturity basket in the Lehman Credit Index. The innovation that distinguished TRAINS® when they were first launched was the simultaneous creation of several maturities. This opened up a possibility of combining several TRAINS® according to their index weights and reliably tracking the overall index with just a few transactions. In general, the selection of appropriate relative weights of various maturity TRAINS® is an efficient way to achieve the desired term structure exposure while matching the sector and quality distribution of a credit benchmark.

TRAINS® were immediately popular with investors looking for efficient access to diversified baskets of liquid corporate names. Fund managers use them to obtain immediate credit market exposure for any cash inflows. For indexers, TRAINS® provide an excellent replication tool. High net-worth individual investors with relatively small amounts to invest view TRAINS® as a means of pooling their resources. To buy the constituent bonds individually, such investors would be forced to purchase small lots and pay very high transaction costs. TRAINS®, on the other hand, usually trade at the bid-ask spread of liquid corporate bonds. In fact, at the outset, they traded with a spread of as little as 3 bp. After the recent liquidity and credit stresses, the bid-ask spread has widened to about 10 bp, but this is still better than the average bid-ask spread of the constituent bonds.

TRAINS® come in many flavors. Currently, there are five U.S. cash TRAINS®: 5-year (\$884 million currently outstanding), 10-year (\$1.3 billion), and “long” (\$456 million) maturities of the Lehman Credit Index, Baa TRAINS® (\$294 million), and high-yield TRAINS® (\$182 million), representing the B and higher component of the Lehman High Yield Index. The amounts outstanding will get smaller over time if a constituent bond is downgraded below investment grade. TRAINS® holders can choose to receive a *pro rata* distribution of either the removed bonds themselves or the liquidation proceeds. There is also a flexible redemption option that allows investors to receive a *pro rata* share of the underlying bonds.

In May 2002, Lehman Brothers issued a Euro-TRAINS®, a 5-year bullet bond backed by a portfolio of fifty single-name credit default swaps and an underlying Aaa-rated fixed-coupon bond. The 50-name basket was assembled to approximate the spread performance of the Euro Corporate Index. Investors who want to track the index's total return must complement a position in Euro-TRAINS® with, for example, bond futures, in order to capture yield curve as well as spread effects. The use of credit default swaps allows for a broader basket of names and facilitates secondary trading, because CDS are less prone to issue-specific variations in secondary market liquidity. However, there is CDS-cash

market basis risk, as CDS spreads tend to react faster and amplify spread movements in the cash market. This basis risk may create a source of tracking error. Since launch, secondary trading in Euro-TRAINS® has been a multiple of the modest EUR300 million issued originally, and bid-offer spreads have remained in the region of 5-7 bp. A broad variety of European and global investors has been active in Euro-TRAINS®: fund managers facing cash inflows or expected cash outflows, insurance companies and bank reserve managers who wish to tune their overall credit exposure without having to restructure their existing portfolios, and global investors who find that Euro-TRAINS® are an easy way to obtain issuer diversity in the euro credit market.

Innovation in the credit markets is likely to continue.

Innovation in the credit markets is likely to continue. We expect to see more issuance of TRAINS® and perhaps variations on the theme in the form of exchange-traded funds (ETFs) or baskets representing broader sets of securities (e.g., the Lehman very-liquid credit investment grade and high-yield indices—VLIs).

Issuer-Capped Benchmarks

In 2002, excessive exposure to individual issuers was not just a portfolio management issue. Plan sponsors began to scrutinize their benchmarks for high issuer concentrations. A common question we heard was, “does it make sense for our organization to have a 2% exposure to name XYZ?” Some plans began to demand benchmarks with reduced issuer concentrations. Investors in other asset classes were also affected by the trauma in the investment-grade credit market and high issuer concentration. When WorldCom was downgraded below investment grade in May 2002, it became an immediate heavyweight in high-yield benchmarks (about 4.5% in the Lehman High-Yield Index), forcing indexers to assume equally concentrated exposures in their portfolios. Some asset managers and their clients were understandably reluctant to assume such large absolute exposures that many expected to produce large negative absolute returns, even though the benchmark would suffer from them as well.

The high level of absolute issuer name risk led to the demand for issuer-capped benchmarks.

In some cases, the caps are chosen to be different for various credit ratings, reflecting the differences in issuer-specific risk between higher and lower credit qualities.

The high level of absolute issuer name risk led to the demand for issuer-capped benchmarks. Lehman responded by developing tools for the creation of such custom benchmarks. In the simplest case, a market-value cap (e.g., 2%) can be imposed and every issuer capitalization is checked against this threshold. The market value in excess of the cap is “shaved off” and distributed to all other issuers in the index in proportion to their market values. As a result of the redistribution, some other issuers may now cross the threshold. The process is then repeated until all issuers are below the cap. With a reasonable selection of the cap, only a few out of many issuers are cut, and the process requires no more than two or three iterations. In some cases, the caps are chosen to be different for various credit ratings, reflecting the differences in issuer-specific risk between higher and lower credit qualities.

Time Decay in Estimation of Historical Factor Volatilities

The changed nature of credit risk demanded corresponding adjustments in analytical tools used to measure portfolio risk. In the spring and early summer of 2002, many credit portfolios experienced deviations from the benchmark that exceeded five standard deviations as predicted by the Lehman multi-factor risk model. These deviations were driven almost entirely by events affecting individual issuers. The risk model’s estimate of portfolio risk, based on the long-term historical volatility of residuals in the credit market, was an inadequate predictor of issuer-specific risk in the changed marketplace.

The risk model was enhanced to include a user option to give recent observations more weight in the estimation of idiosyncratic risk than more distant observations.

In response to these events, the risk model was enhanced to include a user option to give recent observations more weight in the estimation of idiosyncratic risk than more distant observations. The weighting scheme is exponential time decay. The speed of time decay was set to “one year half life” so that with each year of age, an observation’s weight in the estimation was reduced by half. The time decay option lets the risk model adjust to idiosyncratic shocks much faster. As a result, tracking errors predicted by the model increased significantly. In the months following the change, the realized performance of most credit portfolios fell in line with predicted tracking errors.

Users of the risk model should give careful consideration whether to use time decay. It is not necessarily always the best option.

Users of the risk model should give careful consideration whether to use time decay. It is not necessarily always the best option. Indeed, if users had used time decay prior to the 1998 crisis, they would have severely underestimated their tracking error, as the experience of the 1990 recession would have been significantly underweighted. In general, one should not use time decay after a few years of market calm. When, at some point, the current high idiosyncratic volatility comes to an end, managers looking for conservative estimates of risk should, in our opinion, switch back to the equal weighting scheme.

The introduction of time decay was part of the general overhaul of the Lehman multi-factor risk models in 2002. New models were developed for all asset classes in the Lehman U.S. Aggregate Index. Some of them, such as ABS and CMBS, did not have a risk model before. The models for the government, credit, and MBS markets were redesigned to use different methods of return splitting and of measuring interest rate and volatility risk. Key rate durations are now used to describe the term structure risk; vegas represent sensitivity to volatility risk; and the specifications for systematic and non-systematic spread risk have changed. The new models, covering both U.S. and Euro Aggregate indices, have been implemented in our new portfolio analytics software platform (POINT).

While investors were concerned during much of 2002 with the risk of holding credit positions, toward the end of the year, we began to hear from investors who anticipated “performance opportunity!”

Strategies for Outperforming in a Credit Portfolio

While investors were concerned during much of 2002 with the risk of holding credit positions, toward the end of the year, we began to hear from investors who anticipated “performance opportunity!” Investor sentiment had become so negative that some investors began to sense a bottom. As this was not the first time that the credit market peered into the abyss, perhaps history could offer a dispassionate perspective on the potential for recovery. Investors began to ask us to evaluate the outperformance potential of various credit strategies.

Somewhat to our surprise, distressed bonds as a group have historically produced positive excess returns over the two-year horizon. Moreover, they outperformed quality- and duration-matched peer groups.

First and foremost, most investors had little choice but to confront the question of what to do with distressed bonds in their investment-grade credit portfolio. (Our definition of a distressed bond is a bond with an option-adjusted spread above 400 bp and a price below 80% of par.) Are you better off holding, selling, or buying more? We examine⁹ the performance of such bonds over the two-year period following the month of distress (the month when both of the stated conditions were satisfied for the first time). For securities that ended in default, we use a very conservative zero-recovery assumption. Somewhat to our surprise, we find that even under such assumptions, distressed bonds as a group

⁹ *Risk and Return for Low-Price Investment-Grade Bonds*, Lehman Brothers Global Relative Value, May 2002 and *Return Performance of Investment-Grade Bonds After Distress*, Lehman Brothers Global Relative Value, July 2002. Please refer to our website at www.LehmanLive.com for an update to this study through November 2002.

have historically produced positive excess returns over the two-year horizon. Moreover, they outperformed quality- and duration-matched peer groups.

Second, does the current difficult economic environment hold promise for the high-yield market? In recessions, the high-yield market tends to underperform the investment-grade market by a wide margin. This was the case in the recession of 1990 and has been the case during 2002. Yet high-yield may lead investment-grade when the economy rebounds. In fact, we show that high-yield does outperform investment-grade credits in economic recoveries.¹⁰ This trend is also present within the high-yield market, as Caa-rated bonds outperform more highly rated bonds in recoveries. Investors expecting the economy to improve in 2003 may reap benefits from overweighting lower-quality credits.

Buy-and-hold investors, on the other hand, are concerned primarily with default risk. Assuming that this premise is correct, we expect to find a significant cushion protecting a diversified credit portfolio from underperforming Treasuries because of defaults.

The sharp increase in credit volatility in 2002 was accompanied by an increase in spreads. The high spreads are supposed to compensate investors for the increased risk. But are investors over-compensated? Technical risks such as short-term volatility and liquidity are relevant only to portfolio managers that are marked-to-market or trade actively. Buy-and-hold investors, on the other hand, are concerned primarily with default risk. Assuming that this premise is correct, we expect to find a significant cushion protecting a diversified credit portfolio from underperforming Treasuries because of defaults. In a recent study,¹¹ we conduct a simple break-even analysis to find the default rate that would make a diversified corporate portfolio's holding period return over ten years equal to that of Treasuries. Assuming that the number of defaults in a portfolio follows a binomial distribution, we model the worst-case portfolio return with a given confidence for a given market-wide default rate. We then look at the inverse problem—for the worst-case portfolio return to be equal to our Treasury benchmark, what is the maximum market default rate that could be tolerated for this level of performance? We show that this break-even market default rate would have to be significantly higher than historical averages and would exceed even the worst-case observed levels.

5) Prospects

Despite the turbulence in our fixed-income world, the year could have been much worse. Instead, overall total returns for 2002 were very strong, both absolutely and relative to other asset classes. Despite the good showing of our debt asset class, prospects for traditional fixed-income managers may be changing dramatically. For many years, plan sponsors have considered their fixed income portfolios as an “anchor-to-windward,” a source of stability for their overall portfolio. During the past decade, with robust equity returns, plan sponsors tolerated low absolute fixed-income returns and were generally satisfied with their fixed-income managers if they produced returns close to the benchmark. After all, equities were producing tremendous absolute returns, and many sponsors considered them “riskless” because they were long-term investors. The ax against fixed-income was that bonds sold for close to par and their upside was capped at par. Unlike equities, fixed income did not offer much potential for substantial gains. In fact, many plan sponsors steadily reduced their allocation to fixed income. Not only did sponsors decline to rebalance after years of strong equity returns, they also moved money from fixed income to equities.

¹⁰ “High Yield Investing During Economic Recovery,” Lehman Brothers *Global Relative Value*, August 2002.

¹¹ “A Case for Credit Investing in Buy-and-Hold Portfolios,” Lehman Brothers, *Global Relative Value*, December 2002.

While fixed-income managers may celebrate the renewed attention paid to their asset class, performance expectations are rising, when they should be probably falling through the middle of this decade.

Three years of strongly negative equity returns have changed this view. Some plan sponsors have reallocated assets back to fixed-income. In fact, some European sponsors have dramatically increased their allocation to fixed income. While fixed-income managers may celebrate the renewed attention paid to their asset class, performance expectations are rising, when they should be probably falling through the middle of this decade. We all hear that we are in a world of relatively low asset returns. While equities prices are well below their peaks, their valuation may still be rich according to some calculations—fully anticipating an economic recovery. In such a low-return world, plan sponsors must seek out returns wherever they might originate—equities, fixed income, or alternative assets. For some plans, viewing their fixed-income portfolio simply as an anchor-to-windward may be an unaffordable luxury of bygone years.

In reaction to this development, fixed-income managers may be required to become more absolute rate of return oriented, rather than relative rate of return oriented.

In reaction to this development, fixed-income managers may be required to become more absolute rate of return oriented, rather than relative rate of return oriented. Alternatively, plan sponsors may choose to customize their benchmarks to conform better to their new return expectations. If the index is down 6%, plan sponsors will be unsatisfied if the fixed income manager is down only 5.5%. In an era of low asset returns, it is much more difficult to make up for a down year. Portfolio managers will be required to protect positive returns (perhaps using derivatives such as credit default swaps and Treasury futures) while at the same time looking for upside potential. Furthermore, even if some clients were still looking for relative returns (*i.e.*, benchmark returns plus or minus), the growth of ETFs and other low-cost passive strategies will prove to be strong competition for traditional fixed-income money managers.

Traditional fixed-income money managers also will be forced to respond to growing competition from hedge funds.

Traditional fixed-income money managers also will be forced to respond to growing competition from hedge funds. Given their fee structure, hedge funds have the incentive, focus, and tools to produce absolute returns, not relative returns. Fixed-income managers will have to respond, and they are going to have to demand the flexibility from plan sponsors to be able to compete. Based on what we are hearing, we anticipate the following developments.

Plan sponsors are naturally suspicious of investment strategies that have not undergone thorough analysis.

Increased Use of Quantitative Strategies for Performance

Plan sponsors are naturally suspicious of investment strategies that have not undergone thorough analysis. Plans are willing to give managers an opportunity to perform just as long as the manager has a reasonable basis for expecting good performance. While everyone knows that what has worked well in the past may not work well in the future, plans would still like to see good objective evidence that a strategy has worked well and a reasonable argument for why it will work going forward. If a manager can produce such a strategy tool, he is likely to be well received. For example, this view is supported by the warm reception afforded to our ESPRI credit selection model.

The ESPRI credit selection model is the product of an extensive empirical study of the relationship between corporate bond spread movements and their issuers' equity momentum, as measured by past equity returns. Motivated in part by the consistent evidence¹² of momentum in the equity markets, the goal of the model was to formalize

¹² See, for example, Jegadeesh, N., and S. Titman, 1993, "Returns to Buying Winners and Selling Losers: Implication for Stock Market Efficiency," *Journal of Finance*; Rouwenhorst, G., 1998, "International Momentum Strategies," *Journal of Finance*.

and quantify the observation by traders and portfolio managers that movements in the stock price can anticipate movements in credit spreads. Employing a simple sorting based system for classifying bonds of a broad universe, the identified patterns are robust across currencies, ratings, sectors, and liquidity levels, as well as through time.

As an asset selection tool, ESPRI has proved successful both in a rigorous back-testing framework¹³ and in action over the past eighteen months throughout the tough corporate bond markets in various currencies. Most notably, the model frequently provided early warning of the numerous dramatic credit events and downgrades that have plagued the market over this period. Portfolio managers and traders use ESPRI model output as a screening system on their universes to identify dynamically potential problematic names and sectors, as well as to spot advantageous buying opportunities. As a portfolio-structuring tool, ESPRI provides a systematic framework for selecting bonds—or through a simple extension, credit default swaps—and offers flexibility around investment horizons. The model is also an aid to fundamental analysts and strategists, allowing them to broaden their universe of coverage and acting as a further input for their analysis. The ESPRI results are available in our credit publications both in the U.S. (*Market Advisor*) and Europe (*European Credit Strategies Monthly* and *Impact Issuers List*).

Another quantitative strategy that has received increased attention has been our “No-View” Treasury Optimization strategy.

Another quantitative strategy that has received increased attention has been our “No-View” Treasury Optimization strategy. This dynamic strategy imposes a minimum return requirement (e.g., zero) but allows the portfolio’s duration to change periodically in response to market conditions. NVO uses historical returns to determine the risk of various points on the yield curve, but not to project their expected returns. To estimate expected returns, the investment manager is assumed to have “no view” on the movement in interest rates. The manager simply assumes that the current yield curve will be the yield curve at the end of his review period (say, one quarter). Given the current yield curve and the review period, expected returns and standard deviation of returns can be calculated for various maturity points. The minimum return requirement, at a given level of confidence, specifies the allowable amount of risk. With expected returns and a minimum return requirement, we can construct the portfolio with the highest expected return for this given amount of risk. Investors have used NVO for several years with good risk-adjusted results under a variety of different parameter settings.

Quantitative strategies can produce significant risk-adjusted returns—generally low returns but at relatively low levels of risk.

Quantitative strategies can produce significant risk-adjusted returns—generally low returns but at relatively low levels of risk. To capitalize on the strategy, the plan sponsor should allow the manager to use leverage to increase the risk of a given strategy up to the level of market risk so as to increase expected returns commensurately. Ideally, the manager will have numerous efficient strategies to employ. Quantitative strategies are often transitory—they work for a while, then stop. Having several independent strategies at work simultaneously allows managers always to be participating in strategies that are profitable and to garner the diversification benefits of following multiple independent strategies.

¹³ “Introducing ESPRI: A Credit Selection Model Using Equity Returns as SPRead Indicators,” 2002-Q1 edition of *Lehman Brothers Quantitative Credit Research Quarterly*.

Increased Use of Derivatives to Generate and Protect Absolute Returns

To generate and protect absolute returns, managers will need authority to use derivatives such as Treasury futures, swaps, options, and credit derivatives (e.g., credit default swaps). Many of these markets are liquid, transparent, and have low transactions costs. Derivatives allow managers to alter quickly the positions of their portfolios without the difficulty of buying and selling cash bonds. Derivatives are an excellent tool for protecting absolute portfolio returns. If the competition (*i.e.*, hedge funds) can use them, then traditional portfolio managers need to have access to the same tools. In fact, not using derivatives produces a quantifiable performance drag relative to those managers who do use derivatives.

Portfolio managers who cannot use futures are limited in how they can position their portfolios to take advantage of anticipated market moves. For example, a manager operating under a no-futures (*i.e.*, no-leverage) constraint cannot easily implement a pure bullish view on interest rates. A typical way to add duration to a portfolio is to underweight the short-duration part of the market and overweight the long part. However, such a position is clearly not a pure duration play because it is also exposed to a flattening of the curve. This combination has not been an effective one historically. Generally, falling rates have been associated with a *steepening* of the curve. Shifting portfolio exposure from the short end of the curve to the long end therefore leads to performance drag compared with a “pure” duration strategy that uses futures (*i.e.*, leverage) to increase duration exposure all along the curve.

In a recent study,¹⁴ we quantify the performance drag suffered by portfolio managers who cannot use leverage. For managers who cannot use leverage, their achieved information ratio is reduced anywhere from 6% to 23%. In a world of low returns, such a performance drag places the portfolio manager at a tremendous competitive disadvantage.

Increased Use of Risk Models

If plan sponsors demand greater returns from their fixed-income portfolios and allow the use of derivatives and leverage, they will also demand increased use of risk management tools. A portfolio manager requesting the use of derivatives will have to convince the plan sponsor that he or she can quantify his risk. In general, the move to greater risk seeking and global portfolios will require increased reliance on quantitative risk models. To accommodate the complexity of portfolio strategies, plan sponsors will have to give their managers risk budgets, *via* a risk model, rather than a static and inflexible list of investment guidelines.

We hear that some firms are building their own global risk models. Other firms are happy to work closely with Lehman Brothers as we develop our Global Risk Model during 2003. Whether the risk model is homegrown or provided by a broker/dealer, portfolio managers who can demonstrate that such a risk management tool is part of their portfolio management process will go a long way in convincing their clients to allow them to seek greater absolute returns and keep the business.

¹⁴ *Cost of the No-Leverage Constraint in Duration Timing*, Lehman Brothers, October 7, 2002.

6) Conclusions

Some of the unusual trends in the portfolio management process we saw in 2002 may be temporary and may revert to the historical norm.

Some of the unusual trends in the portfolio management process we saw in 2002 may be temporary and may revert to the historical norm. For example, the increasing popularity of issuer-capped benchmarks may represent investor preference for avoiding name-specific risk in the current credit environment. Taken too far, however, departure from market weights in an index may make it difficult to replicate. Concentration in the picks of a credit analyst was traditionally the main driver of the information ratio in a credit portfolio. "Diversification at all cost" may give way to the traditional name selection management style. Similarly, assigning higher weights to more recent historical observations in determining systematic and security-specific risk may be appropriate in the current market environment but may understate risk during a period of low volatility.

However, many market developments of 2002 will have a lasting and often permanent effect on portfolio management.

However, many market developments of 2002 will have a lasting and often permanent effect on portfolio management. The movement of asset management mandates from Global Government Indices to the Global Aggregate seems to be gathering strength. Customized benchmarks are increasingly used alongside market-weighted indices. Swap indices and asset-swapped benchmarks are increasingly in demand by investors.

Most important, quantitative techniques of portfolio construction and risk analysis have become mainstream tools for most portfolio managers.

Most important, quantitative techniques of portfolio construction and risk analysis have become mainstream tools for most portfolio managers. Many are turning to these techniques for selecting strategies and budgeting risk in multi-dimensional Global Aggregate portfolios. While prior to this recession, risk analysis was often seen as an *ex-post* controlling function, in the future, it will be used more as an *ex-ante* tool for evaluation of trades. Risk analysis is also the basis for constructing index-replicating portfolios. They are often used in complex mandates such as the Global Aggregate for some parts of the overall portfolio. Diversification requirements and security selection in credit portfolios will be determined by some combination of fundamental analysis and quantitative models. We expect a busy 2003 for our Quantitative Portfolio Strategy Group.

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