# Equity Turbulence, Fixed Income Illiquidity, and Portfolio Reallocation: *The Case for Synthetic Rebalancing*

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The catastrophic performance of global equity markets in 2008 has left many asset owners significantly overweight fixed income and underweight equities. As equity markets rally, this imbalance presents significant return implications in addition to potentially lowering plans' actuarial rates of return. Given the equity market turbulence of 2008, a typical plan with a 60/40 equity/fixed income allocation that has undertaken no corrective rebalancing would be 15% underweight to equities (and overweight to fixed income). Even if the same plan had rebalanced to target in June of 2008, it would still be more than 12% away from its strategic asset allocation. This is no hypothetical scenario; during the difficult equity markets between September 2008 and the end of the year, most plans decided either to not rebalance or simply to increase their rebalancing tolerances.

Efficient portfolio rebalancing has always been a complex exercise for plans. In the current unprecedented market conditions, this challenge has been further complicated by two unique circumstances. First, as of April 2009, the fixed income market is extremely illiquid outside of the safest bonds. Second, many plans participate in securities lending programs. The current illiquid nature of the fixed income market has forced many securities lending providers to include lending collateral as part of any redemption. For example, a client wishing to take $100 million out of a fixed income index fund would receive a portion of the redemption in collateral trading below par—despite many of these instruments being good credits. Selling such bonds at current market prices would lock in losses on assets that many expect to mature at par.

Current market conditions make it difficult to rebalance using normal policies, but they do not make it impossible. While many plans, intimidated by the complexity and cost of rebalancing, have chosen to simply widen the tolerance bands on their asset allocation, others have turned to the derivatives market to achieve cost-efficient rebalancing. These plans are using fixed income and equity index futures to short out the duration exposure of fixed income portfolios and create long positions in the equity market, synthetically rebalancing their assets until normal market conditions return.

## A BRIEF HISTORY OF POST-TURBULENCE REBALANCING

An examination of 13 other periods of market turbulence suggests that synthetic rebalancing is not only efficient, but wise. The preponderance of historic evidence suggests that funds that do not rebalance after turbulence—or indeed exacerbate imbalances by increasing their fixed income allocations—do so at their own risk. To determine optimal rebalancing strategies in a post-turbulence

market, we undertook a quantitative study of fund performance using current plan sponsor asset allocations and multiple rebalancing methods to assess the theoretical performance of each rebalancing method.

We used the aggregate asset mix for large U.S. public defined benefit plans as a set of strategic policy weights in our model portfolio. According to *Pensions & Investments* magazine, this allocation is approximately 47% domestic equity, 23% international equity, 27% domestic fixed income, 1% international fixed income, and 2% cash.[1] Next, we estimated the annualized return and risk (standard deviation) of each asset class based on monthly returns from January 1986 through November 2008. Exhibit 1 shows these values at both the asset-class level and at the portfolio level. We used total returns for all asset classes. Exhibits 2 and 3 show distributions of the monthly returns for each asset class, for the portfolio, and for the global stock and bond components.[2]

We ranked the model portfolio's monthly returns from January 1986 to November 2008 and identified the largest negative portfolio returns. We then identified 13 notable financial market crises for analysis. Exhibit 4 presents portfolio performance for these "unlucky" months and the corresponding market events. The first column in Exhibit 4 gives the rank of each month in terms of monthly portfolio return; the top rank belongs to the worst monthly portfolio return and the 275th rank belongs to the best monthly portfolio return (9.17%, in January 1987).[3]

Exhibit 5 presents portfolio returns, together with disaggregated stock and bond component returns, for each of these "market crisis" months. Exhibit 6 shows the stock and bond allocation mix at the end of each crisis month, assuming that the portfolio was invested at its target weights (70% equity, 28% bonds, 2% cash) at the beginning of the crisis month. By examining both returns and changes in allocation in the wake of turbulent months, we can gauge the magnitude of asset weight drift that resulted from each event.

Exhibit 7 illustrates the evolution of the asset weights—assuming the portfolios began at target allocations and were not rebalanced after the market events—in the

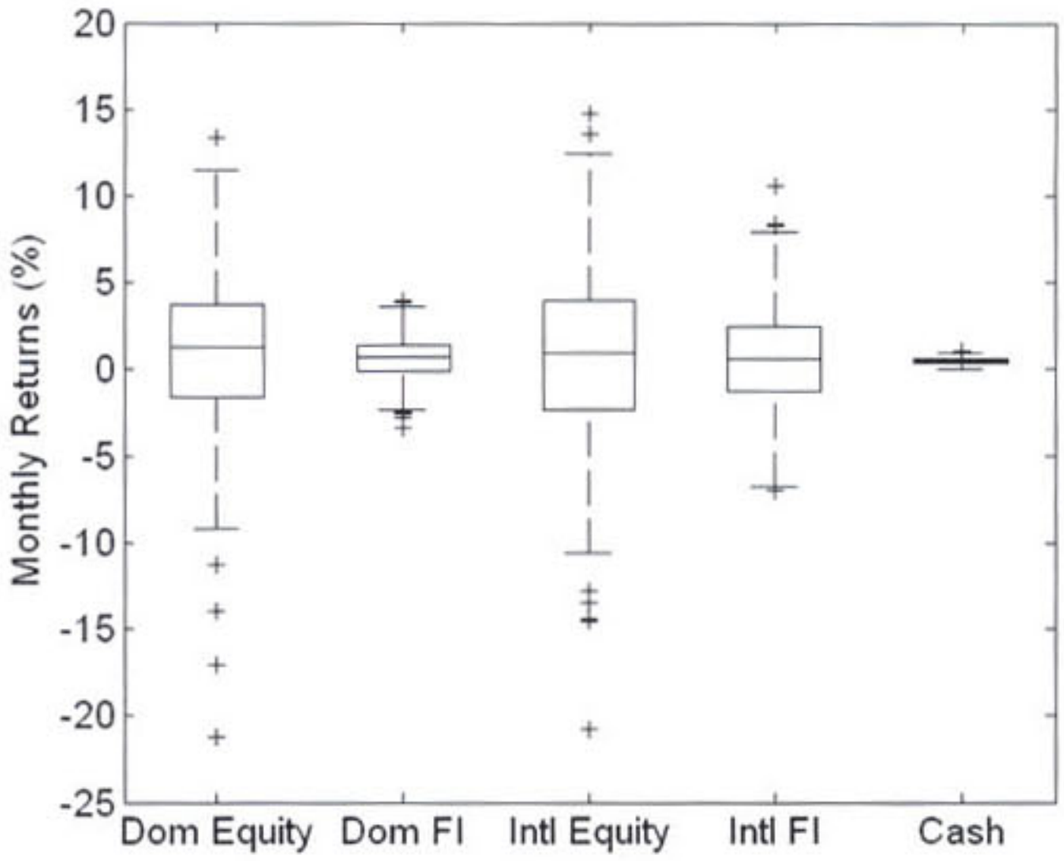
## EXHIBIT 1

**Portfolio Statistics Monthly Returns January 1986 through November 2008**

| Asset Class | Annualized Return | Annualized Risk |
|---|---|---|
| Domestic Equity | 10.35% | 17.04% |
| Domestic FI | 7.52% | 4.46% |
| International Equity | 9.12% | 19.02% |
| International FI | 9.25% | 10.61% |
| Cash | 5.43% | 0.71% |
| *Portfolio* | 9.18% | 11.51% |
| *Stocks* | 9.94% | 16.20% |
| *Bonds* | 7.58% | 4.45% |

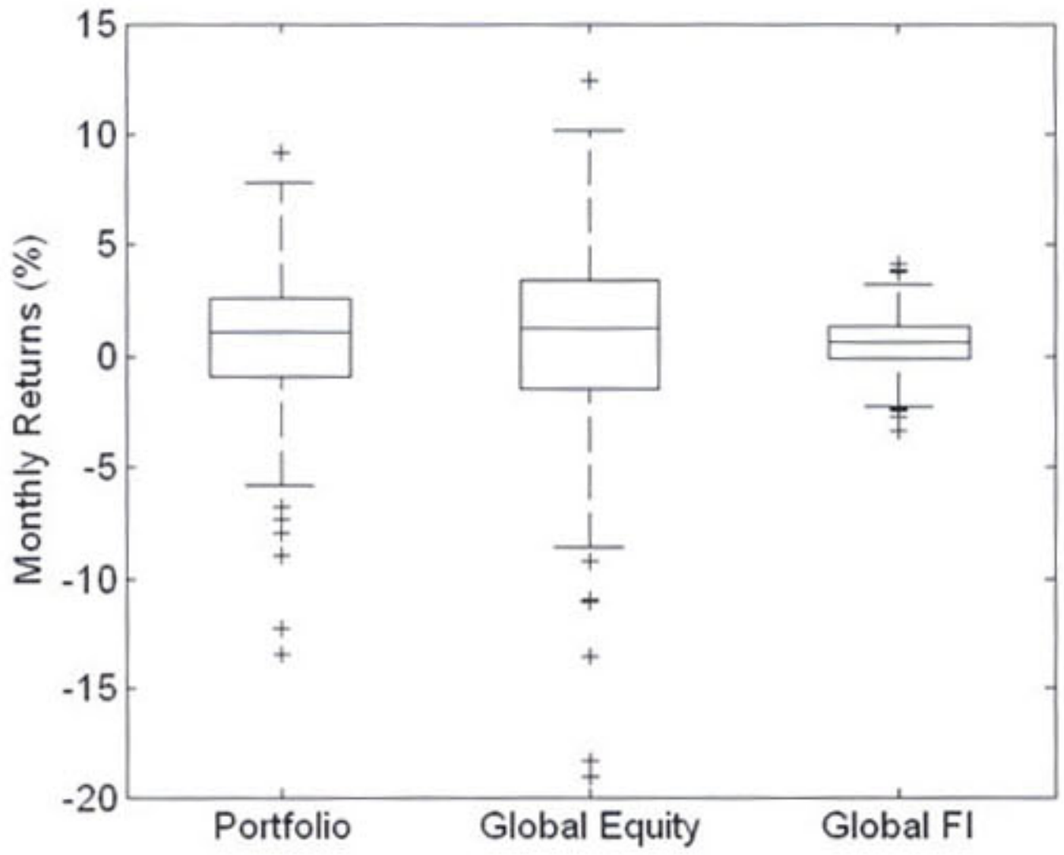
## EXHIBIT 2

**Distributions of Monthly Returns by Asset Class**




## EXHIBIT 3

**Distributions of Monthly Returns for the Portfolio, Global Equity, and Global Fixed Income**



## EXHIBIT 4
**Portfolio Performance and Market Events**

| Rank | Notable Financial Market Crisis | Month | Portfolio Return |
|---|---|---|---|
| 1 | Credit Crisis | Oct-08 | −13.44% |
| 2 | Black Monday | Oct-87 | −12.25% |
| 3 | LTCM, Russian Default | Aug-98 | −8.99% |
| 4 | Credit Crisis | Sep-08 | −7.99% |
| 5 | N/A | Sep-02 | −7.30% |
| 6 | S&L Crisis | Aug-90 | −6.81% |
| 7 | Tech Bubble Burst | Feb-01 | −5.78% |
| 8 | Credit Crisis | Jun-08 | −5.63% |
| 9 | September 11 | Sep-01 | −5.58% |
| 10 | Accounting Fraud | Jul-02 | −5.33% |
| 11 | S&L Crisis | Sep-90 | −5.03% |
| 12 | Asian Financial Crisis | Aug-97 | −4.69% |
| 22 | Mexican Peso Crisis | Mar-94 | −3.66% |

one-month, three-month, six-month, and one-year periods following each event.

Exhibit 7 suggests that the average equity underweight one month after an event (–3.02%) is greater than the average equity underweight one year after an event (–1.89%). Indeed, for 70% of the events for which data is complete, the equity underweight "self corrected" to the extent that equity valuations experience at least a partial post-event recovery. Of course, the fact that the equity underweight diminishes over time when left to its own devices also suggests that in many cases investors could have achieved superior returns by actively rebalancing into equities following the event.

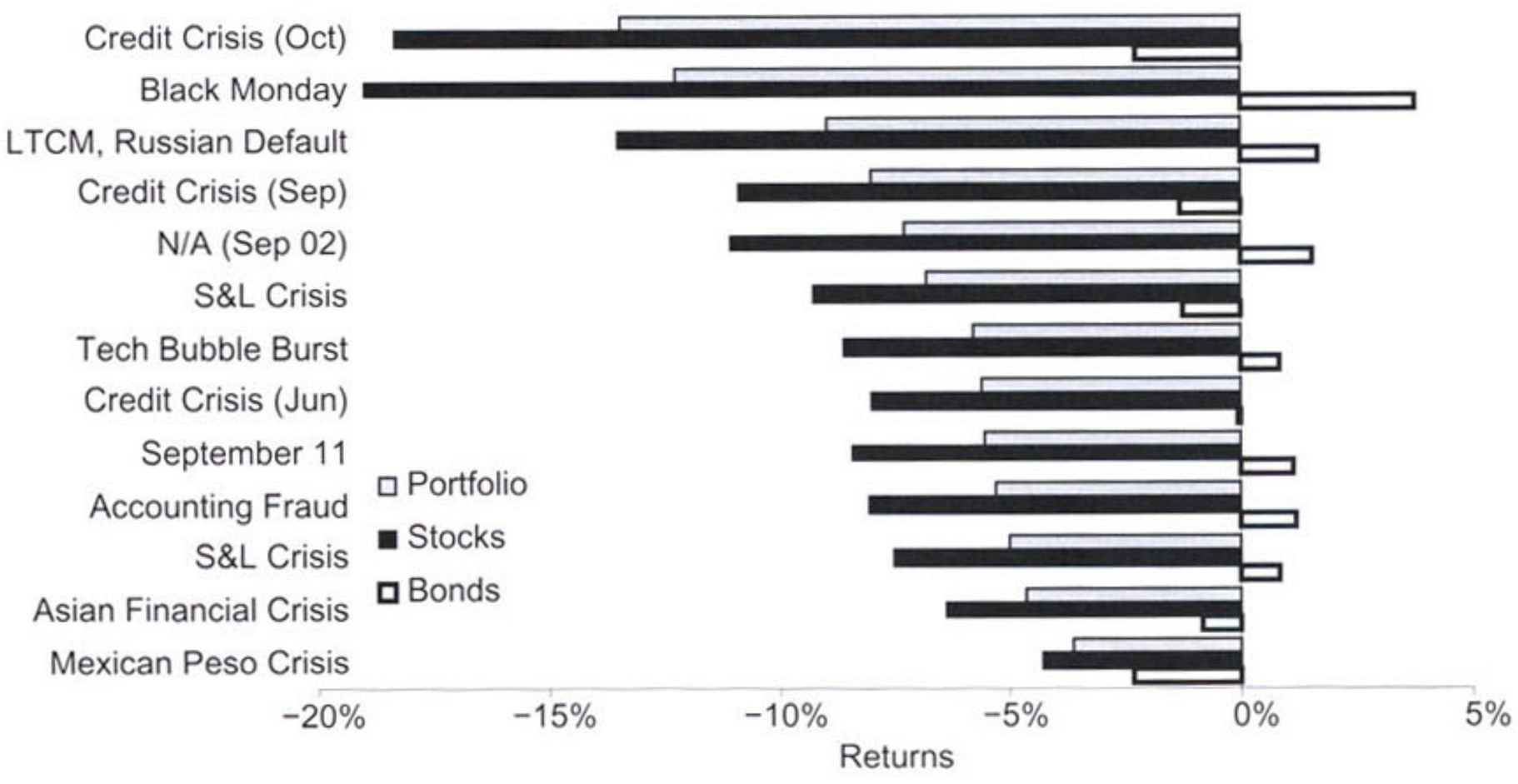
## THREE REBALANCING STRATEGIES

Based on the market events in our sample, the underperformance of equity in the immediate wake of a market crisis typically causes an underweight to equity in a portfolio, as seen in Exhibit 6. Turbulence always shakes up strategy. In the face of uncertainty and potential continued negative equity performance, investors face three broad choices—with the long-term efficacy of each approach depending on the subsequent relative performance of equity and fixed income investments in the wake of turbulence.

### No Rebalancing

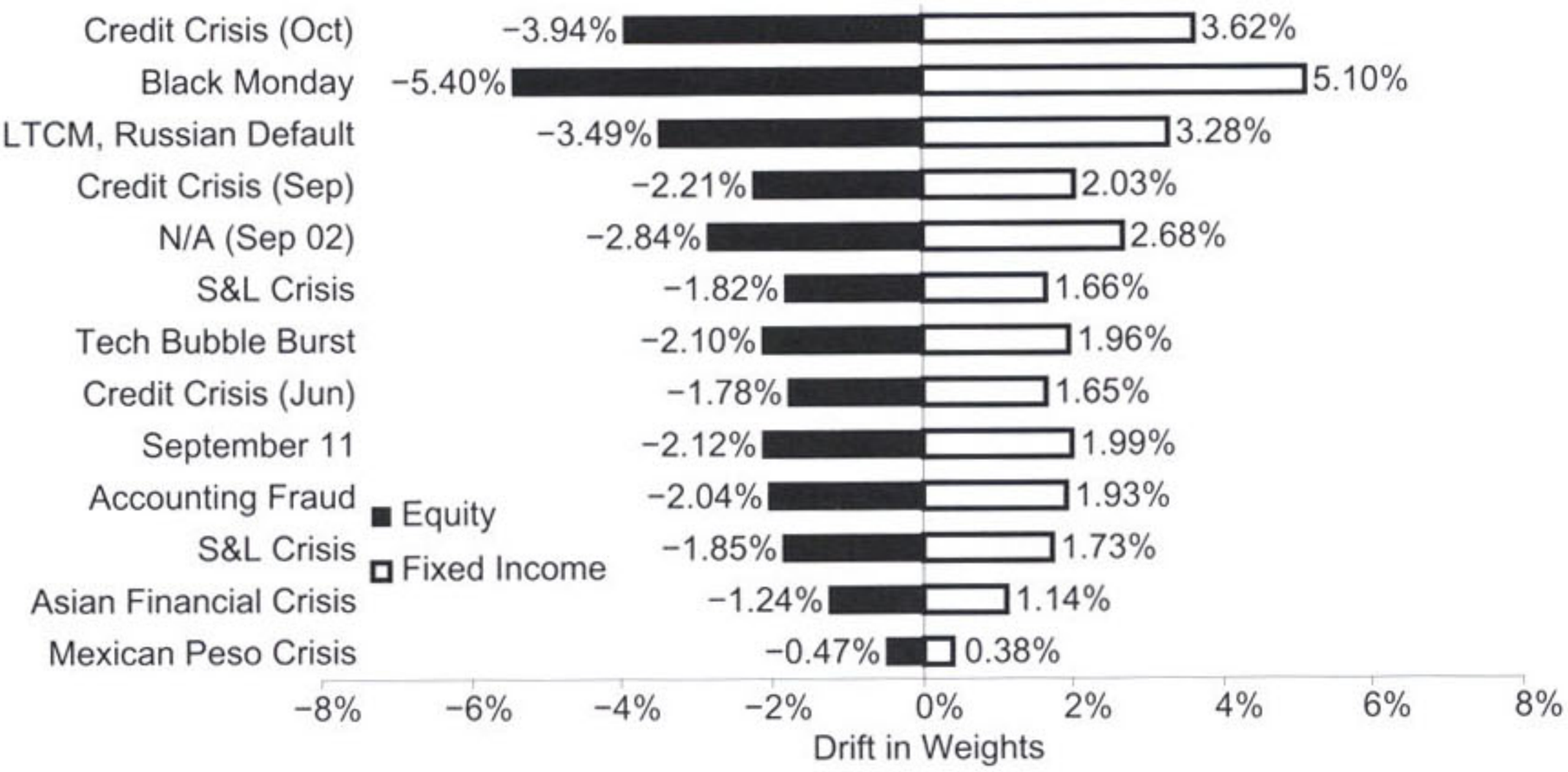
Assume that the portfolio allocation was at the target as of the beginning of the month in which the market event occurred. There is no rebalancing after the event. This constitutes the baseline policy, as it may be the default course of action after a market crisis. (Indeed, in some crises, liquidity constraints may prevent investors from rebalancing even when they wish to do so.)

## EXHIBIT 5
**Returns In Crisis Months**



## EXHIBIT 6

**Allocation Drift at the End of the Month (From Target 70% Equity and 28% Fixed Income)**




## EXHIBIT 7

**Post-Event Portfolio Allocation Evolution from Pre-Event Allocation of 70% Equity, 28% Bonds**

| | One Month Post Event | | Three Months Post Event | | Six Months Post Event | | Twelve Months Post Event | |
|---|---|---|---|---|---|---|---|---|
| Month | Equity | Bond | Equity | Bond | Equity | Bond | Equity | Bond |
| Oct-08 | 63.78% | 33.80% | n/a | n/a | n/a | n/a | n/a | n/a |
| Oct-87 | 63.13% | 34.49% | 64.09% | 33.66% | 65.48% | 32.32% | 65.80% | 32.05% |
| Aug-98 | 66.75% | 31.10% | 69.80% | 28.23% | 71.06% | 27.02% | 72.71% | 25.42% |
| Sep-08 | 63.72% | 33.76% | n/a | n/a | n/a | n/a | n/a | n/a |
| Sep-02 | 68.89% | 29.05% | 68.49% | 29.46% | 67.19% | 30.69% | 70.93% | 27.23% |
| Aug-90 | 66.27% | 31.45% | 66.99% | 30.82% | 69.33% | 28.67% | 69.05% | 28.97% |
| Feb-01 | 66.35% | 31.41% | 67.75% | 30.09% | 64.81% | 32.90% | 63.32% | 34.31% |
| Jun-08 | 67.81% | 30.03% | 65.29% | 32.36% | n/a | n/a | n/a | n/a |
| Sep-01 | 67.86% | 30.05% | 69.76% | 28.22% | 69.83% | 28.15% | 61.10% | 36.46% |
| Jul-02 | 67.67% | 30.22% | 66.52% | 31.31% | 65.42% | 32.38% | 68.83% | 29.19% |
| Sep-90 | 68.75% | 29.19% | 69.06% | 28.94% | 71.00% | 27.13% | 70.46% | 27.70% |
| Aug-97 | 69.57% | 28.40% | 68.89% | 29.04% | 70.59% | 27.47% | 68.00% | 29.92% |
| Mar-94 | 70.16% | 27.79% | 70.06% | 27.86% | 70.67% | 27.28% | 70.93% | 27.09% |

### Monthly Rebalancing

Assume that the portfolio is rebalanced to the target allocation at the end of every month, regardless of the market crisis.

### Defensive Reallocation

Assume that the portfolio allocation was at the target as of the beginning of the month in which the market event occurred. At the end of that month, a defensive shift into fixed income is taken, increasing the fixed income allocation to 38% (as opposed to the 28% target) and reducing the equity allocation to 60% (as opposed to the 70% target).

To assess their relative merits, we compared the one-, two-, and three-year post-event cumulative returns resulting from each policy for the 13 "unlucky" market events identified in Exhibit 4. We looked at the difference in returns between the no-rebalancing policy and the monthly rebalancing policy, as well as between the no-rebalancing policy and the defensive reallocation.

Exhibits 8, 9, and 10 compare the one-, two-, and three-year post-event cumulative return differences between no rebalancing and monthly rebalancing, and between no rebalancing and defensive reallocation.[4] Exhibit 11 summarizes the success rate of the monthly rebalancing policy and the defensive reallocation relative to no rebalancing, as well as the average performance of each relative to no rebalancing.

These results indicate that:

- In the majority of the market events under consideration, monthly rebalancing outperforms both no rebalancing and the defensive reallocation at the one-, two-, and three-year horizons.
- Monthly rebalancing also outperforms both other rebalancing policies on average. Additionally, the difference between no rebalancing and monthly rebalancing is less variable across the market events than is the difference between no rebalancing and defensive reallocation. In other words, sometimes the defensive reallocation results in much better performance than no rebalancing (or monthly rebalancing), while at other times the defensive reallocation performance is much worse than either of the other two rebalancing strategies at the one-, two-, and three-year horizons.[5]
- The underperformance of the defensive strategy relative to no rebalancing increases with the passage of time.
- The outperformance of the monthly rebalancing strategy relative to no rebalancing increases with the passage of time.

Exhibit 12 shows the detailed performance results of all three rebalancing policies for each of the 13 market events after one, two, and three years. It is interesting to note that in the two cases where the one-year post-event cumulative return was negative (and only in these two cases), the defensive reallocation would have been the best-performing rebalancing policy, as this approach would have yielded a slightly higher, though still negative, return.

## COST-EFFICIENT REBALANCING METHODOLOGY

Having established the importance of rebalancing, we must now define methods to effect rebalancing in current market conditions. As the trading of physical positions to rebalance is extremely costly given the illiquidity of the market, rebalancing should be undertaken using optimized long/short derivative portfolios.

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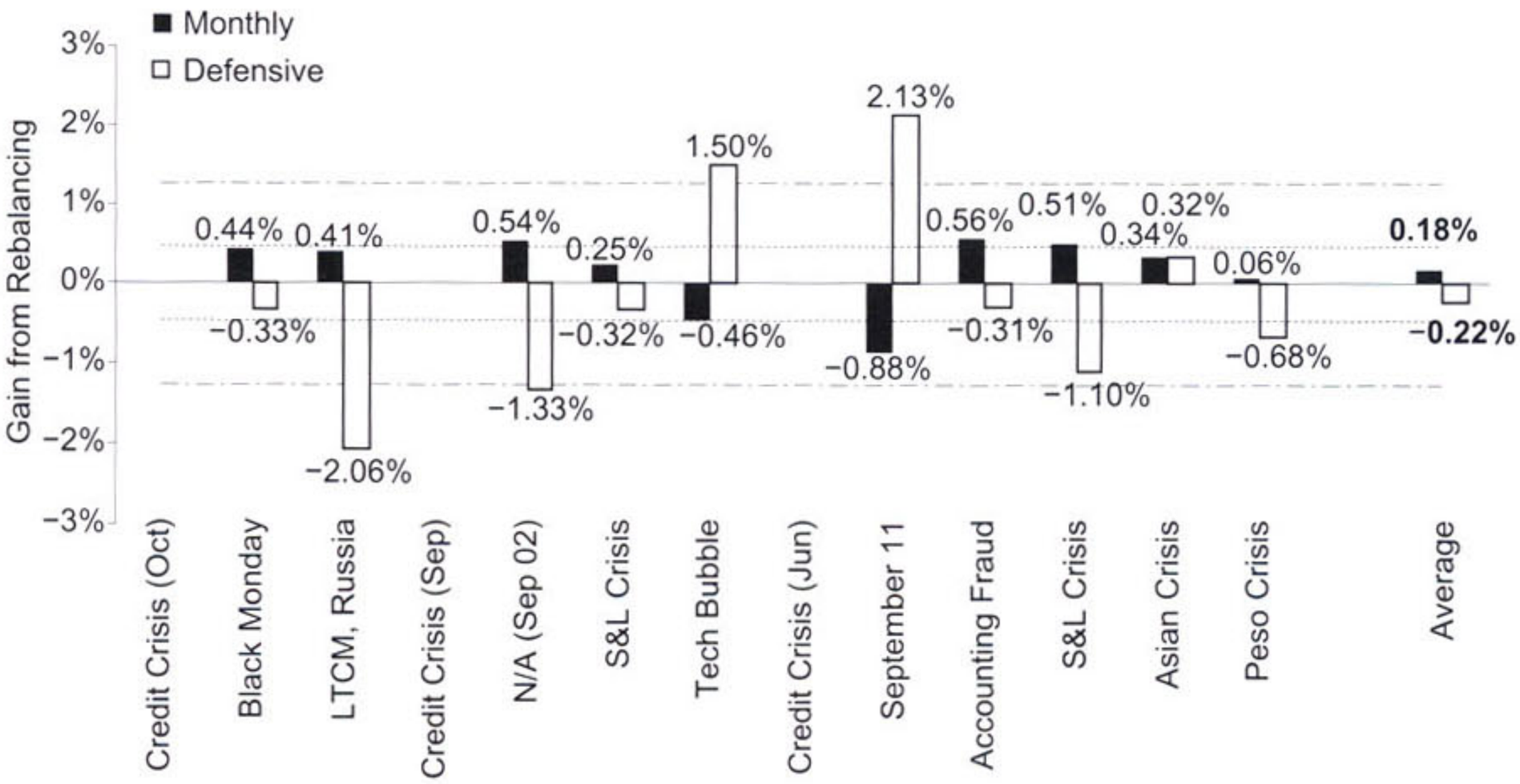
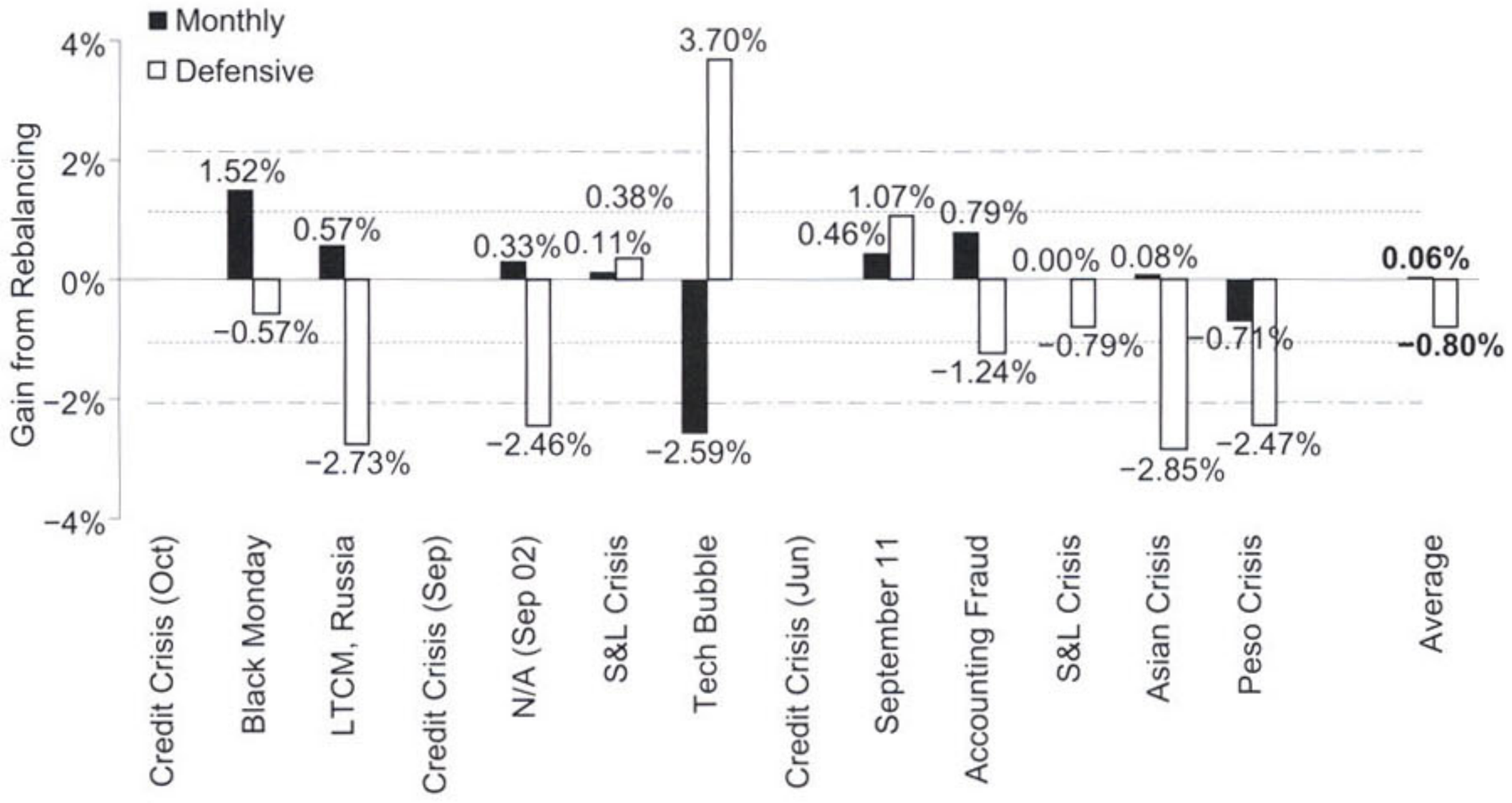
## EXHIBIT 8

**One-Year Gain From Rebalancing Policies vs No Rebalancing**



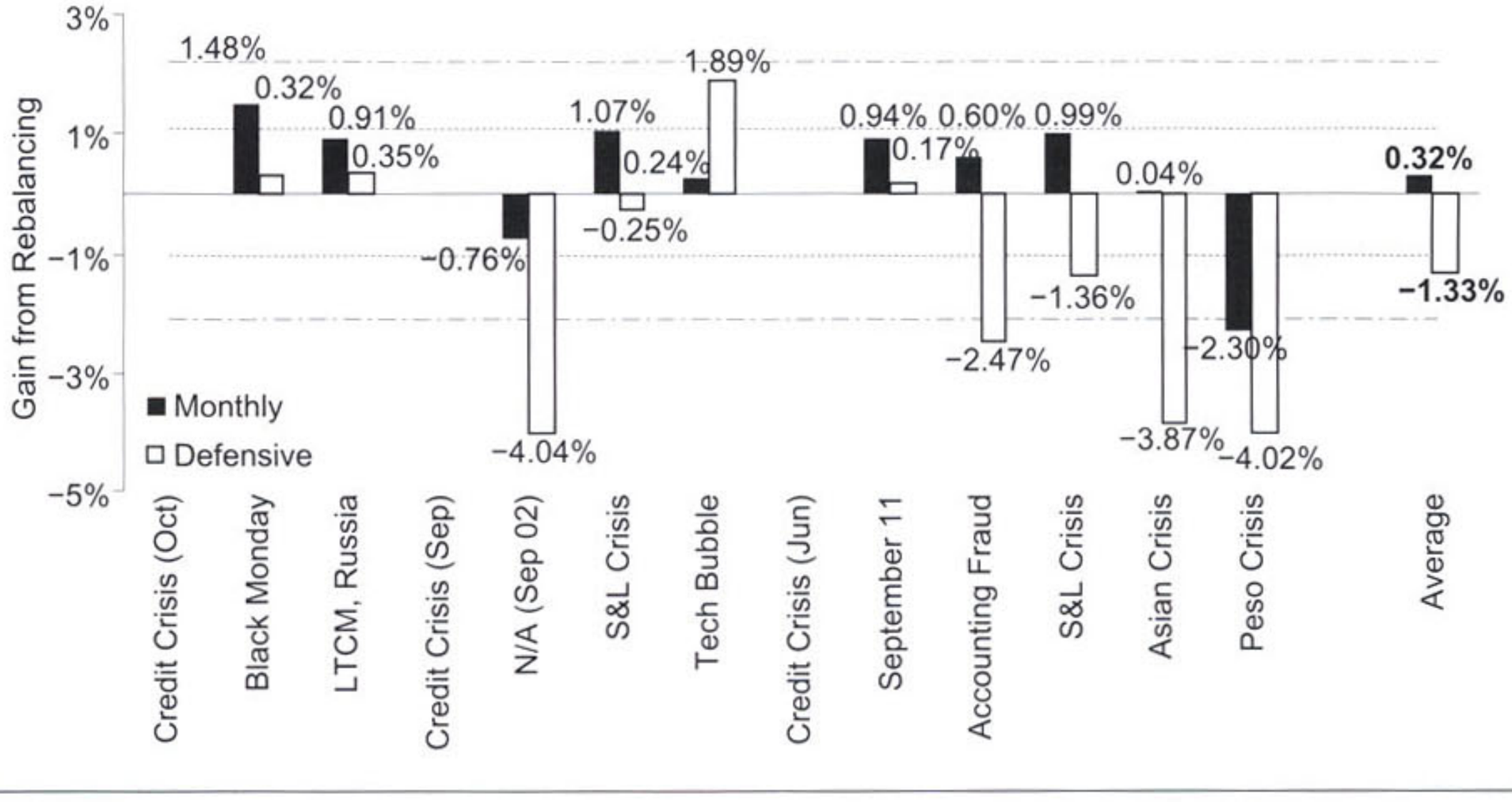
## EXHIBIT 9

**Two-Year Gain From Rebalancing Policies vs No Rebalancing**




## EXHIBIT 10

**Three-Year Gain From Rebalancing Policies vs No Rebalancing**




The long portion of the overlay is straightforward. For popular U.S. equity benchmarks, investors can use highly liquid futures contracts to replicate the S&P 500 Index, S&P 400 Index, and Russell 2000 Index with fairly low transaction costs and tracking error. Replication of global equity benchmarks is a bit more complicated given the amount of contracts needed in addition to the currency aspect of a global mandate. Exhibit 13 details sample baskets for popular U.S. benchmarks and the associated tracking error and expected transaction costs. For transaction costs, we have assumed $10 million in trading.

## EXHIBT 11

**Success Rate and Average Performance vs No Rebalancing**

| | Success Rate | | Average Performance | |
|---|---|---|---|---|
| Horizon | Monthly | Defensive | Monthly | Defensive |
| 1-year | 80% | 30% | 0.18% | −0.22% |
| 2-year | 70% | 30% | 0.06% | −0.80% |
| 3-year | 80% | 40% | 0.32% | −1.33% |

Contracts exist for MSCI EAFE, and MSCI Emerging Markets, although the liquidity and open interest associated with each of these contracts is typically not sufficient for large asset owners. Exhibit 14 shows the liquidity, open interest, and expected transaction costs associated with implementing these contracts.

For most U.S. investors, local country futures and currency forwards/futures should be used to hedge local exposure, with optimization used to determine the weights of the local contracts. But this strategy is complicated by the fact that there are certain countries that do not have futures contracts available to U.S. investors, as they are not CFTC approved[6]—notably Switzerland, where the local equity contract, SMI Index, is not available for U.S. investors. This creates tracking error in any global basket. There are also countries that have futures available and are CFTC approved, but in which markets are highly illiquid and not practical for a short-term rebalancing exercise. Exhibit 15 details the expected tracking error of optimized futures baskets relative to various benchmarks used by asset owners. Finally, some basis risk exists due to the fact that many country futures baskets are based on local indexes (i.e. FTSE, CAC Dax, etc.) rather than on more global index families such as MSCI.

### SHORTING FIXED INCOME

To short the fixed income overweight, investors most often use U.S. Treasury contracts. Historically,

## EXHIBIT 12

**Cumulative Return One, Two, Three Years Post Event for Rebalancing Policies**

| | One Year | | | Two Years | | | Three Years | | |
|---|---|---|---|---|---|---|---|---|---|
| Market Event (Month) | No Rebalance | Monthly | Defensive | No Rebalance | Monthly | Defensive | No Rebalance | Monthly | Defensive |
| Credit Crisis (Oct 08) | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Black Monday (Oct 87) | 1.15% | 1.59% | 0.82% | 18.12% | 19.63% | 17.55% | 13.79% | 15.27% | 14.11% |
| LTCM, Russia (Aug 98) | 13.25% | 13.66% | 11.19% | 26.83% | 27.40% | 24.09% | 7.09% | 8.00% | 7.43% |
| Credit Crisis (Sep 08) | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| N/A (Sep 02) | 10.43% | 10.97% | 9.10% | 24.66% | 25.00% | 22.21% | 42.07% | 41.31% | 38.03% |
| S&L Crisis (Aug 90) | 9.30% | 9.55% | 8.98% | 18.28% | 18.39% | 18.66% | 36.95% | 38.02% | 36.70% |
| Tech Bubble (Feb 01) | −11.81% | −12.27% | −10.31% | −20.41% | −23.00% | −16.71% | 0.42% | 0.65% | 2.31% |
| Credit Crisis (Jun 08) | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| September 11 (Sep 01) | −15.67% | −16.55% | −13.54% | −0.56% | −0.11% | 0.50% | 11.58% | 12.52% | 11.75% |
| Accounting Fraud (Jul 02) | 2.52% | 3.08% | 2.21% | 15.81% | 16.59% | 14.57% | 31.77% | 32.37% | 29.30% |
| S&L Crisis (Sep 90) | 18.27% | 18.78% | 17.18% | 27.49% | 27.49% | 26.70% | 45.77% | 46.76% | 44.41% |
| Asian Crisis (Aug 97) | 2.39% | 2.73% | 2.71% | 28.20% | 28.28% | 25.36% | 43.75% | 43.79% | 39.88% |
| Peso Crisis (Mar 94) | 6.63% | 6.69% | 5.96% | 30.08% | 29.38% | 27.62% | 46.69% | 44.39% | 42.68% |

## EXHIBIT 13

**Sample U.S. Equity Replication**

| Benchmark | S&P 500 Future Weight | S&P 400 Future Weight | Russell 2000 Future | Expected Tracking Error[1] | Expected T-Costs[2] |
|---|---|---|---|---|---|
| Russell 1000 | 89.5% | 10.5% | – | 0.28% | 0.03% |
| Russell 3000 | 82.8% | 9.2% | 8.0% | 0.26% | 0.04% |
| Wilshire 5000 | 82.0% | 9.1% | 8.9% | 0.27% | 0.04% |
| S&P 1500 | 89.0% | 7.9% | 3.1% | 0.06% | 0.03% |
| S&P 1000 | – | 71.8% | 28.2% | 0.54% | 0.06% |

*Notes: [1]Expected tracking error is annualized; [2]Expected transaction costs are State Street estimates.*

## EXHIBIT 14
### EAFE and Emerging Markets Liquidity

| Benchmark | Average Daily Turnover | Open Interest | Expected T-Costs[1] |
|---|---|---|---|
| MSCI EAFE | $132,110,753 | $1,737,233,750 | 0.17% |
| MSCI EMERGING MARKETS | $26,245,000 | $782,530,000 | 0.55% |

*Note: As of December 31, 2008. [1]Expected transaction costs are State Street estimates.*

## EXHIBIT 15
### Global Equity Benchmarks

| Benchmark | Expected Tracking Error[1] | Expected T-Costs[2] |
|---|---|---|
| MSCI EAFE | 1.30% | 0.08% |
| MSCI EAFE & Canada | 1.19% | 0.08% |
| FTSE World ex USA | 1.19% | 0.08% |
| MSCI ACWI ex USA | 1.56% | 0.09% |
| MSCI World | 0.59% | 0.06% |
| Non-US Investors | | |
| MSCI EAFE | 0.59% | 0.070% |
| MSCI World | 0.39% | 0.060% |

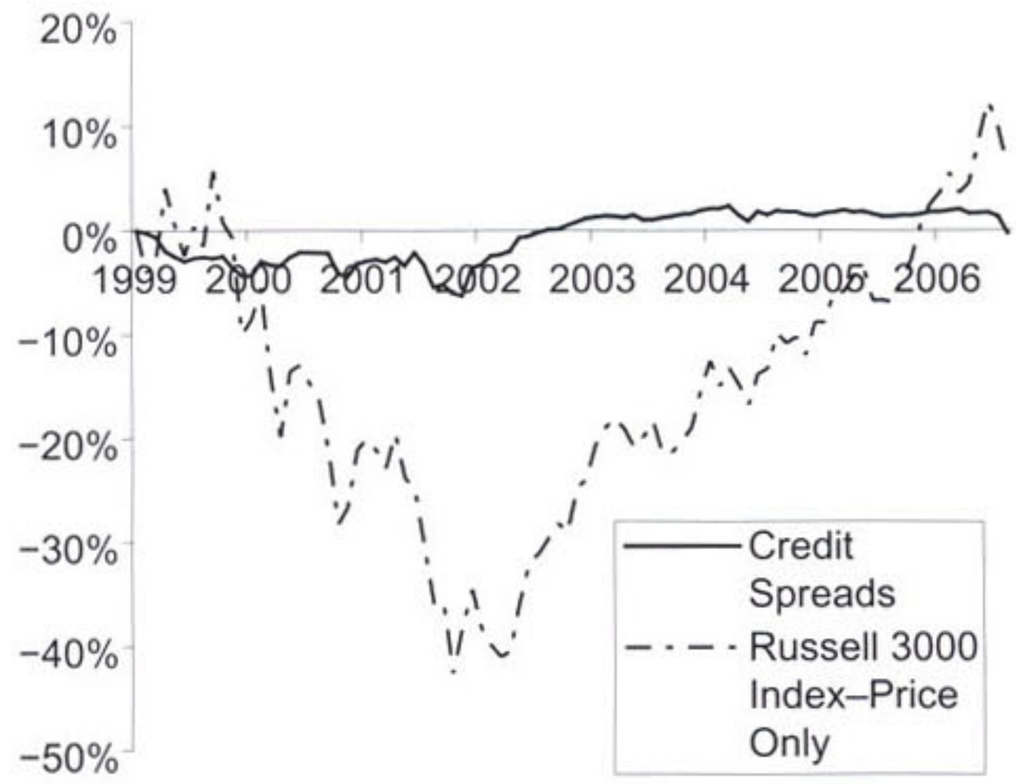
*Notes: [1]Expected tracking error is annualized; [2]Expected tracking costs are State Street estimates.*

shorting of the Lehman (Barclays) Aggregate Bond Index (LBAG) could be accomplished by simply using futures in which U.S. Treasury 2-, 5-, 10-, and 30-year futures contracts would be sold. The goal of the overlay would be to short duration and yield curve exposure equal to the LBAG Index. This hedge had tracked the LBAG Index quite closely. However, the credit dislocation that began in 2007 and has continued through the current time has caused credit spreads to widen and increased the correlation between corporate bonds and equities.

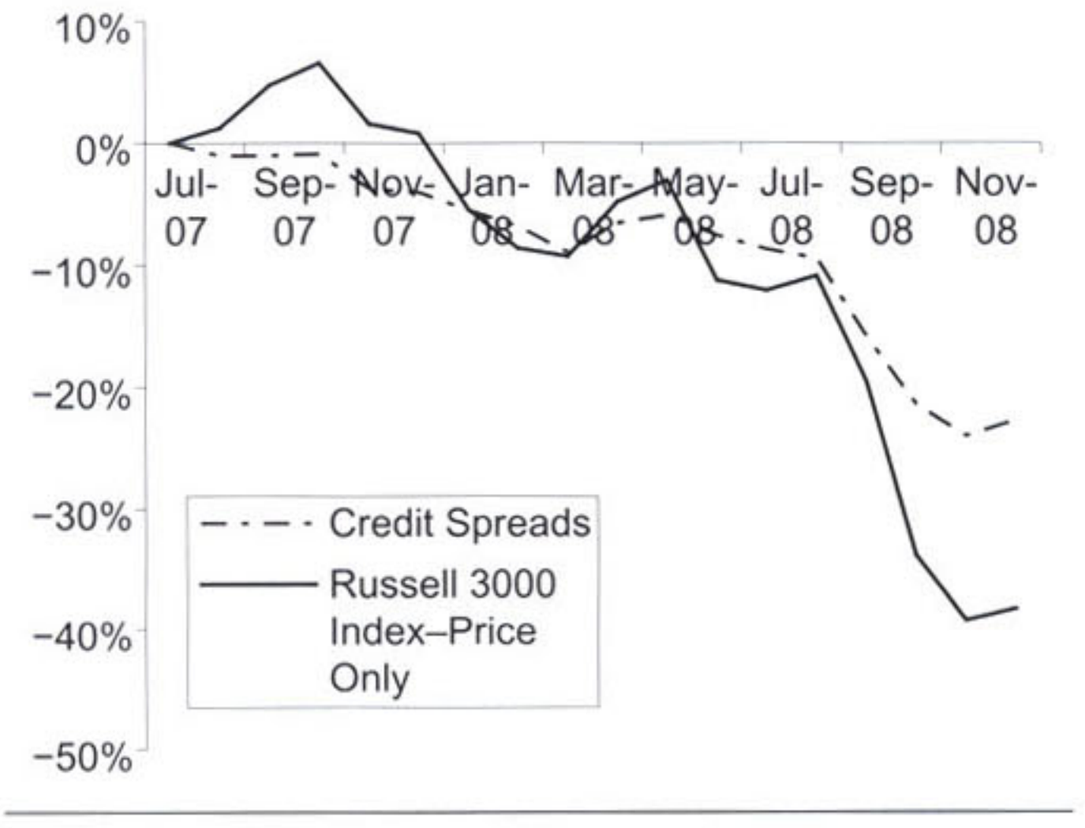
Exhibits 16 and 17 detail credit spreads, from the LBAG Index, versus the price return of the Russell 3000 Index. Prior to July 2007, there was very little correlation between credit spreads and equity performance; but since July 2007, the correlation of credit spreads versus the Russell 3000 Index has risen to 0.85.

The rising correlation between credit spreads and the significant decline in correlations between Treasuries and credit spreads have caused the need to change overlay protocol. Exhibit 18 details the performance

## EXHIBIT 16
### Credit Performance vs Russell 3000 Index December 1999–July 2007




## EXHIBIT 17
### Corporate Bonds vs Russell 3000 Index–July 2007–December 2008




of using short Treasury futures to hedge exposure to the LBAG.

While year-to year there were variances as high as 175 basis points, the year 2008 was an outlier in that Treasuries outperformed the LBAG by over 700 basis points. Assuming U.S. Treasuries are 30% of the LBAG Index, all other sectors within the LBAG returned 2.18% for the year. Exhibit 19 details the breakdown in correlation between credit and U.S. Treasuries.

The other significant allocation within the LBAG is to securitized products, with a heavy emphasis on mortgage-backed securities. It is important to note that the vast majority of mortgage-backed securities within the LBAG index are conventional mortgages and have not been widely affected by the credit crisis. This may be different than most asset owners' mortgage portfolios. Exhibit 20 details the performance of the mortgage portion of the LBAG versus U.S. Treasuries.

It is important to note as well that correlation has not changed dramatically for MBS versus Treasuries, as shown in Exhibit 21.

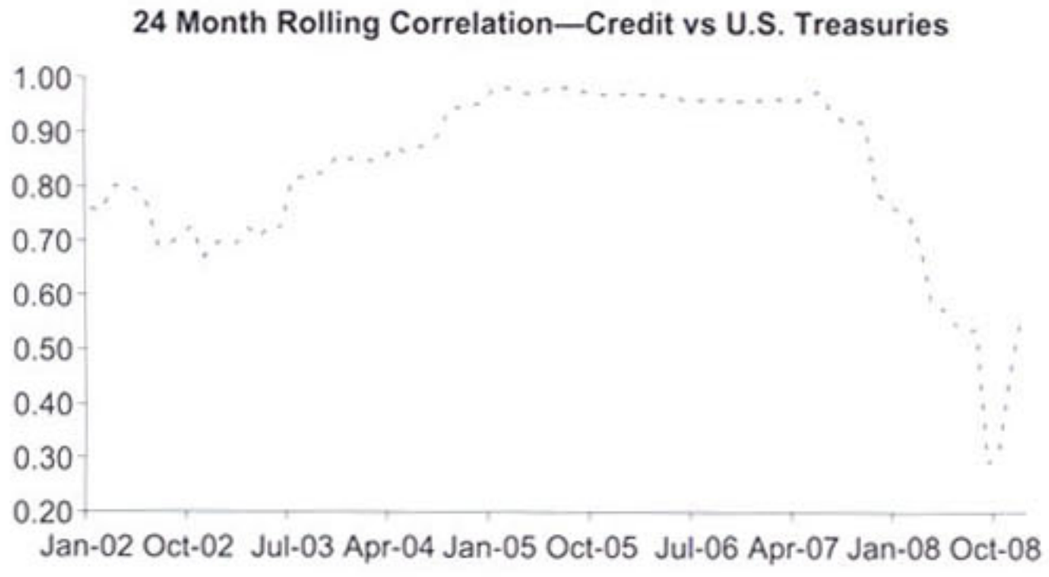
Given the dislocation between U.S. Treasuries and Credit, traditional overlays that use U.S. Treasuries as a proxy for all fixed income exposure introduce significant basis risk. Therefore, an optimal hedge will take into account the rising correlation between credit spreads and equities, thereby altering the hedge. When looking over the last 18 months of data, the optimal hedge ratio for long short overlays is 0.87. Thus, a plan sponsor overweight $100 million in fixed income exposure and underweight $100 million in equity exposure should short $100 million in duration weighted fixed income exposure, and go long $87 million in equities. Effectively, this overlay will eliminate all the duration exposure of the fixed income portfolio but plans will still remain overweight to credit, as no credit exposure is sold. Given that the credit spreads exposure still exists and that correlations are still high between credit spreads and equities, only 87% of the long equity exposure is hedged. This strategy would be dynamically rebalanced based on the relationship between credit spreads and equities. Utilizing Treasury futures we can construct an optimal hedge for the fixed income portfolio. We match the appropriate U.S. Treasury contract(s) to each bucket and short an equal amount of duration. The breakdown of the LBAG and the corresponding U.S. Treasury contracts are shown in Exhibits 22 and 23.

Before any reallocation or rebalancing takes place, effective transition managers will first understand the components of any client's fixed income portfolio and optimize any hedge based on current holdings. Clients with heavy concentration in corporate bond products or high yield

## EXHIBIT 18
### Performance of Short Treasury Overlay vs LBAG

| Year | Lehman Aggregate Return | Short Treasury Return | Tracking Error to Target | Cumulative Tracking Error |
|---|---|---|---|---|
| 2000 | 11.63% | 13.24% | −1.62% | −1.62% |
| 2001 | 8.44% | 7.23% | 1.21% | −0.38% |
| 2002 | 10.25% | 11.50% | −1.24% | −0.04% |
| 2003 | 4.10% | 2.36% | 1.75% | 0.49% |
| 2004 | 4.34% | 3.48% | 0.86% | 2.62% |
| 2005 | 2.43% | 2.65% | −0.22% | 0.64% |
| 2006 | 4.33% | 3.48% | 0.86% | 0.63% |
| 2007 | 6.97% | 8.66% | −1.69% | −0.85% |
| 2008 | 5.24% | 12.39% | −7.15% | −8.72% |

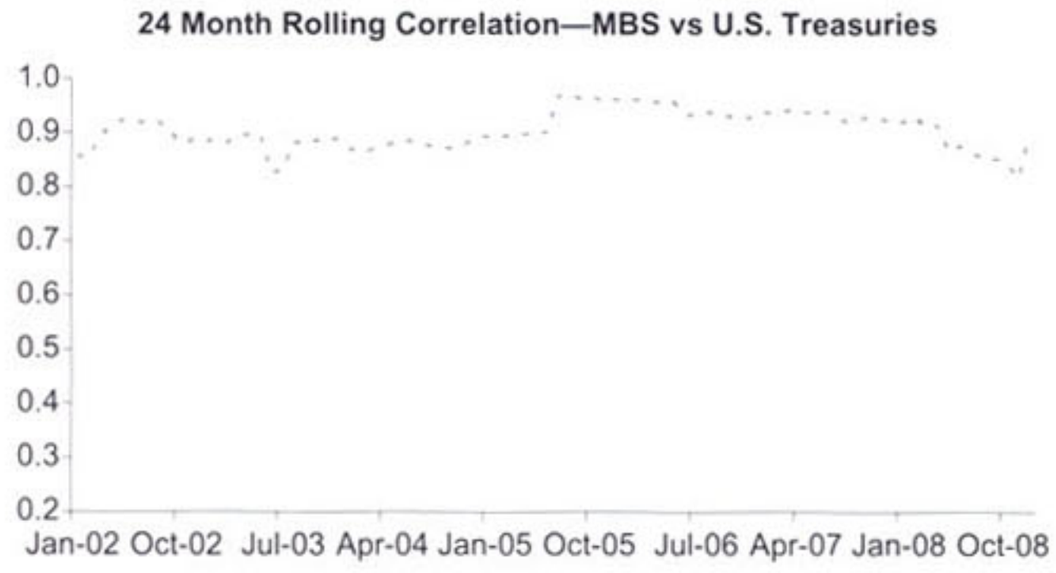
## EXHIBIT 19
### Rolling 24 Month Correlations




## EXHIBIT 20
### Performance of Short Treasury Overlay vs Lehman MBS

| Year | Lehman Mortgage Backed | Short Treasury Return | Tracking Error to Target | Cumulative Tracking Error |
|---|---|---|---|---|
| 2000 | 11.16% | 13.24% | −2.08% | −2.08% |
| 2001 | 8.22% | 7.23% | 0.99% | 0.00% |
| 2002 | 8.75% | 11.50% | −2.75% | −1.78% |
| 2003 | 3.07% | 2.36% | 0.71% | −2.06% |
| 2004 | 4.70% | 3.48% | 1.23% | 1.94% |
| 2005 | 2.61% | 2.65% | −0.04% | 1.19% |
| 2006 | 5.22% | 3.48% | 1.75% | 1.71% |
| 2007 | 6.90% | 8.66% | −1.76% | −0.04% |
| 2008 | 8.34% | 12.39% | −4.05% | −5.74% |

## EXHIBIT 21
### Rolling 24 Month Correlations



## EXHIBIT 22
**Breakdown of LBAG**

| Bucket | LBAG Weight | LBAG Duration | Duration Dollars to Short |
|---|---|---|---|
| 1–3 Yr | 52.7% | 1.41 | 74,332,829 |
| 3–5 Yr | 17.9% | 3.17 | 56,820,341 |
| 5–7 Yr | 6.7% | 4.93 | 32,860,904 |
| 7–10 Yr | 11.4% | 6.66 | 76,051,656 |
| 10+ Yr | 11.3% | 11.59 | 130,649,643 |
| | | | 370,715,374 |

## EXHIBIT 23
**U.S. Treasury Contracts**

| Contract | Duration | Notional Value | Duration Dollars |
|---|---|---|---|
| U.S. 2YR NOTE | 1.90 | 217,984 | 415,224 |
| U.S. 5YR NOTE | 4.41 | 118,891 | 524,100 |
| U.S. 10YR NOTE | 7.81 | 123,516 | 964,141 |
| U.S. LONG BOND | 12.67 | 128,891 | 1,633,512 |

already have high equity correlation within their fixed income portfolios. Rebalancing to equities may not be appropriate in these cases.

## CONCLUSION

The unprecedented market turbulence of recent months has raised critical questions about portfolio allocation and rebalancing, and these questions have been rendered yet more complex over the unique market illiquidity associated with this turbulence. Experience gained in previous bouts of market turbulence suggests that asset owners should strive to maintain their target allocations through regular rebalancing. Given the high cost of rebuilding portfolios that are illiquid and often affected by securities lending programs, investors should use derivative instruments to effect "synthetic rebalancing."

Clearly, the relationship of portfolio optimization, investment allocation, market turbulence, and liquidity is complex and continually changing. Asset owners would do well to keep these issues—and their interrelationship—at the forefront of their strategic thinking.

## ENDNOTES

[1]The average asset mix is based on data from Pensions and Investments Online: http://www.pionline.com/apps/pbcs.dll/article?AID=/20080121/CHART/401969275/-1/PENSIONFUNDDIRECTORY. We rescale and round the allocations to arrive at the numbers given.

[2]The box has lines at the lower quartile, median, and upper quartile values. The whiskers are lines extending from each end of the box to show the extent of the rest of the data. Outliers are data with values beyond the ends of the whiskers. If there is no data outside the whisker, a dot is placed at the bottom whisker.

[3]For context, the month of November 2008 ranks 21st in terms of worst portfolio returns in our sample, with a return of −3.78%.

[4]These computations include the month of the market crisis as well as the following 12, 24, and 36 months, respectively.

[5]This variability is summarized by the standard deviation of the differences, shown by the dotted lines in Exhibits 8 through 10. For the one-year horizon, the standard deviation of the differences between monthly rebalancing and no rebalancing is 0.48%, while the standard deviation of the differences between the defensive reallocation and no rebalancing is 1.26%. For the two-year horizon, these standard deviations are 1.09% (monthly) and 2.08% (defensive), and for the three-year horizon, these standard deviations are 1.12% (monthly) and 2.15% (defensive).

[6]Congress created the Commodity Futures Trading Commission (CFTC) in 1974 as an independent agency with the mandate to regulate commodity futures and option markets in the United States. The agency's mandate has been renewed and expanded several times since then, most recently by the Commodity Futures Modernization Act of 2000. For more information please visit www.cftc.gov.