Journal of FINANCIAL PLANNING
www.journalfp.net
Expanding the Body of Knowledge in the Financial Planning Profession

ELECTRONICALLY REPRINTED FROM JANUARY 2008

Opportunistic Rebalancing: A New Paradigm for Wealth Managers

by Gobind Daryanani CFP®, Ph.D.

--Gobind Daryanani CFP®, Ph.D., is a managing director at TD AMERITRADE in Jersey City, New Jersey. He is responsible for rebalancing research and products, including the Intelligent Rebalancer. He can be reached at Gobind.daryanani@tdameritrade.com.

Wealth managers traditionally rebalance portfolios quarterly or annually to control risk due to asset class drifts. But there's a new paradigm for planners: rebalance less frequently, but look more frequently to find the best opportunities for rebalancing.

This "opportunistic rebalancing" approach not only controls portfolio risk, but also provides significant return improvements by capturing sporadic buy-low/sell-high opportunities as asset classes drift relative to each other. We will show that, with frequent looking, rebalancing return benefits are significantly improved compared with traditional quarterly or annual rebalancing. For example, by looking frequently but rebalancing only when needed, the average rebalancing benefits are shown to be more than double the benefits of more traditional annual rebalancing.

Of course, a variety of factors may have an effect on rebalancing, so we will discuss sensitivities to historical periods, rebalance bands, rebalancing frequencies, and trading costs and tax costs, for different rebalance methodologies. We will also consider the operational costs of incorporating opportunistic rebalancing in individual planning firms.

Executive Summary

- Wealth managers traditionally rebalance portfolios quarterly or annually to control risk due to asset class drifts. This paper proposes a new paradigm for planners: rebalance less frequently, but look more frequently to find the best opportunities for rebalancing.
- The proposed approach, called opportunistic rebalancing, not only controls portfolio drift, but also provides significant return improvements by capturing buy-low/sell-high opportunities as asset classes sporadically drift relative to each other.
- The paper studies a wide range of market conditions to show that rebalancing return benefits can be more than doubled compared with the traditional annual rebalancing.
- These additional benefits, attributed to transient momentum and mean reversion effects, occur sporadically in time and can only be captured by monitoring portfolios frequently.
- The studies suggest these practical guidelines: (1) use wider rebalance bands, (2) evaluate client portfolios biweekly, (3) only rebalance asset classes that are out of balance—not classes that are in balance, and (4) increase the number of uncorrelated classes used in portfolios.
- The studies show that trading costs and tax deferral are small compared with rebalance benefits.
- Opportunistic rebalancing has already been adopted by a number of leading wealth management firms across the country.

Our conclusion is that the average benefits of opportunistic rebalancing far outweigh the costs.

Two Rebalancing Return Benefits

Within the financial planning industry, it is generally accepted that the rebalancing of asset classes adds additional return benefits to portfolios (Arnott 2002, Tsai 2001, and Buetow 2002).

A study of the literature suggests that there are two potential rebalancing benefits. The first is the defensive avoidance of drift, as illustrated in Figure 1. Let us assume the wealth manager has established the risk tolerance for a client, and the client has agreed to a target equity exposure of 60 percent. Suppose the starting investment portfolio consists of a number of asset classes that have a risk/return trade-off corresponding to Point A in Figure 1. Small drifts may be acceptable, but large drifts outside Zone A would be inconsistent with the investment policy statement (IPS). Typically a 5 percent drift in the equity exposure (55 percent to 65 percent) may be acceptable.

If the portfolio remained unattended, it would stray over time away, from starting-Point A, to other points that are less efficient (have higher risk or lower return, or both) and would violate the client's risk appetite. Rebalancing keeps the portfolio near Point A, thereby controlling risk and return degradations.

For wealth managers who follow strategic asset allocation, rebalancing is necessary maintenance. The need to rebalance is a simple fact of life: the question is not *if*, but *how* you rebalance.

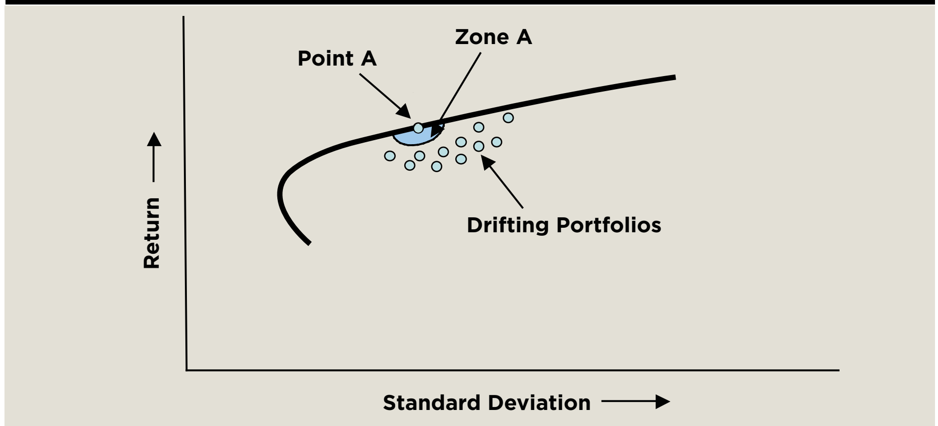
How do planners rebalance? A 2005 survey by this author and the Financial Planning Association of over 100 wealth management firms showed that over 91 percent use some structured rebalancing methodology, while the remaining 9 percent rebalanced ad-hoc based on market conditions.

The survey also showed a preference (over 85 percent) for quarterly, semiannual, or annual rebalancing. Now, if the only objective were to adhere to the IPS and avoid going out of Zone A (Figure 1), and one assumes the drifts over a quarter or a year are small, then rebalancing quarterly or even annually would be adequate. In fact, many studies (Arnott, Goodsall, and Tsai) have shown that there is not much difference in rebalancing benefits between quarterly, semiannual, and annual rebalancing.

A second potential return benefit related to rebalancing can be acquired from capturing buy-low/sell-high opportunities. Consider a portfolio designed with a number of asset classes each having a prescribed target allocation. When the market moves, the allocations of some classes move up or down relative to their targets. These movements provide opportunities to buy asset classes when they are underweighted and to sell securities when they are overweighted.

If you buy a class when it is lower than its target and the class then reverts, your return increases. The implicit assumption is that the underweighted class is also undervalued and reversion to the mean should imply that future returns are expected to be higher than past returns. For similar reasons, if you sell a class when it is above target and it reverts, your return also increases. This contrarian approach of buying low and selling high can generate additional return, assuming the parameters for rebalancing are set appropriately.

Figure 1: Efficient Frontier Showing Drifting Portfolios and Acceptable Zone A for Rebalanced Portfolio



As Goodsall (1994) points out, "Rebalancing is a way of exploiting short-term noise and the volatility of markets and their tendency to overshoot in both directions, and then partially reverse in directions."

Miccolis (2005) expresses this well in describing the periodic table of winning asset classes: "No asset class maintains its spot in the rankings for very long, and there is no discernable pattern as to how any one class moves up or down on the periodic table list from year to year. At more frequent intervals than annual the churn is even more pronounced. There is a lot of relative volatility among asset classes, and what rebalancing does is put this volatility to work for you."

The problem with annual or quarterly rebalancing is that the dates chosen for rebalancing are arbitrary, and thus we cannot possibly expect to catch the juiciest buy-low/sell-high opportunities. For example, most annual rebalancing probably missed the big buy-low opportunities in key dates associated with events like the terrorist attacks on the United States in September 2001; the financial panic during October 2–19, 1987; the Asian stock market crisis of October 7–27, 1997; and many other significant but unprecedented dips or surges in the market that last a few days, but may not even have any identifiable cause.

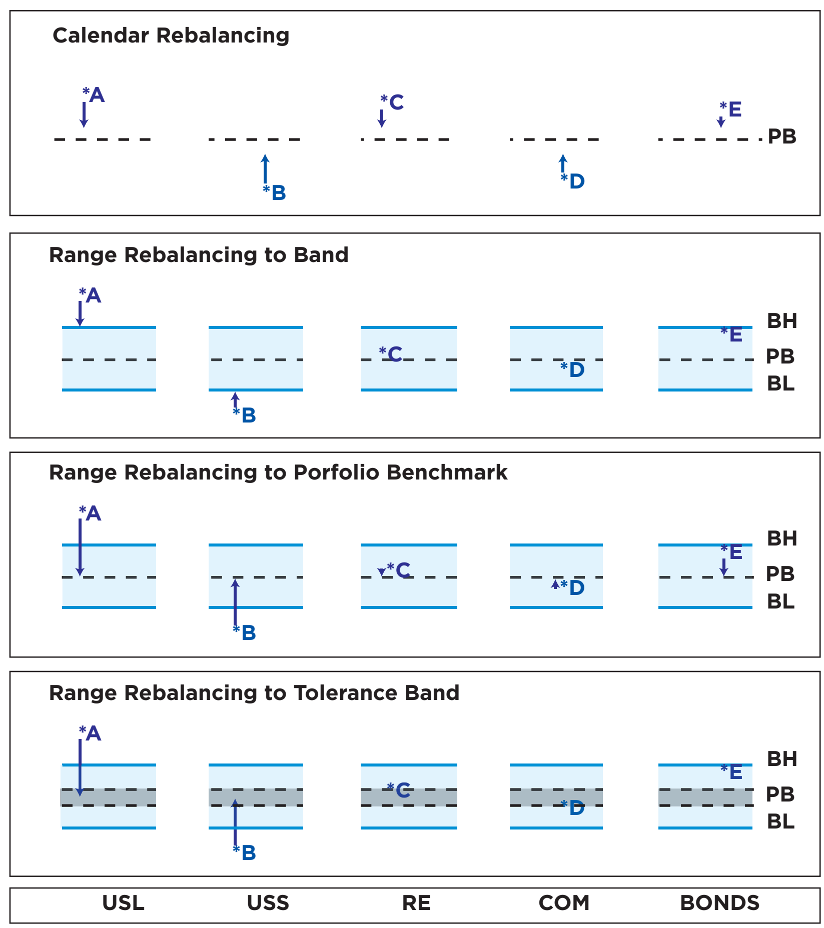
To catch such transient market moves, which are indeed unpredictable, one needs to watch for them constantly. This intuitive observation has been validated in prior research (Buetow 2002, Arnott 2002), which showed remarkable benefits of daily rebalancing over monthly, quarterly, or annual rebalancing.

In the rest of this paper, we will show that these benefits are significant, that they are robust over a range of market conditions, and that one does not need to go to the extreme of daily rebalancing to capture these rebalancing opportunities.

Description of Experiment

Prior studies have analyzed a number of rebalancing methodologies such as calendar rebalancing to portfolio benchmark, range rebalancing to rebalance bands, and range rebalancing to the portfolio benchmark (see Plaxo 2002 for definitions). These algorithms are illustrated in Figure 2. In these approaches, the parameters that can be varied are the rebalance bands and the frequency of rebalancing. The rebalance

Figure 2: Rebalance Approaches



Calendar Rebalancing: All classes are rebalanced to the policy benchmark (PB).

Range Rebalancing to Rebalance Band: Classes are rebalanced only if at least one class is outside the rebalance bands. Then the out-of-balance bands are brought to the edge of the bands. If there are more than two classes, then other classes may have to be rebalanced to ensure buys are equal to sells. This approach may incur some very small trades.

Range Rebalancing to Portfolio Benchmark: Classes are rebalanced only if at least one class is outside the rebalance bands. Then the out-of-balance bands are all brought to the policy benchmark. This may incur some very small trades. If even one asset class is out of band, all asset classes need to be rebalanced to target.

Range Rebalancing to Tolerance Band: Classes are rebalanced only if at least one class is outside the rebalance bands. Then the out-of-balance bands are brought to within the tolerance band.

methodology we propose expands the range rebalance methodology to include an additional parameter, the "tolerance band."

Why do we need to consider a tolerance band? If even one asset class was out of balance, rebalancing to the benchmark would require all five asset classes to be corrected, entailing (at least) five trades.

But if we were to accept a rebalance within a certain tolerance level of the rebalance band, we may be able to correct the one class to within that tolerance with one other buy: that would be two trades, as in the example shown in Figure 2.

This is indeed the way many practitioners rebalance: define a tolerance band and rebalance so that all asset classes are within the tolerance band. This approach will reduce the number of trades. Since this has not been described in prior literature, we have coined the term "range rebalance to a tolerance band" to describe the above. The parameters that are needed to describe the rebalance algorithm are rebalance band, tolerance band, and frequency of looking.

In this study we considered a range of rebalance bands from 0 percent to 25 percent in steps of 5 percent. We then looked to see if any asset class was out of the rebalance band, at different intervals, from annually, semiannually, and quarterly, to monthly, biweekly, weekly, and daily. We use the term "looking" rather than "rebalancing" because we may not need to rebalance (create trades) every time we look or check to see if the asset classes are outside their bands. Note that for the case of a rebalance band of 0 percent, all asset classes must be rebalanced to the portfolio benchmark every time one looks at the portfolio: this sub-case reduces to calendar rebalancing, which is shown in Figure 2.

Classes. For the baseline study, we considered a client with a 60/40 (equity/fixed) portfolio consisting of five asset classes: 25 percent U.S. large (S&P 500 Total Return), 20 percent U.S. small (Russell 2000 Total Return), 10 percent real estate investment trusts (Dow Jones REIT Total Return), 5 percent commodities (Dow Jones AIG Total Return), and 40 percent bonds (Bloomberg 7-10 Total Return). This is a typical asset allocation for a conservative client close to retirement.

Periods. The 13-year baseline period studied was from January 1, 1992, to December 31, 2004. The portfolio annualized mean and standard deviation for this period were 8.0 percent and 8.5 percent, respectively. The choice of period (that is, only back to 1992) was limited due to the sparse availability of earlier daily prices.

Fortunately, this period was rich in the variety of market conditions, so it can be

Table 1: Rebalanced Returns and Benefits for 1992–2004

Panel A: 12-Month Averaged Geometric Returns							
	Look Intervals in Market Days						
Rebalance Bands	250	125	60	20	10	5	1
0%	9.449%	9.381%	9.362%	9.260%	9.137%	8.895%	6.868%
5%	9.453%	9.410%	9.380%	9.385%	9.399%	9.383%	9.377%
10%	9.484%	9.439%	9.452%	9.428%	9.460%	9.450%	9.427%
15%	9.473%	9.521%	9.519%	9.533%	9.534%	9.511%	9.498%
20%	9.497%	9.547%	9.566%	9.584%	9.632%	9.620%	9.684%
25%	9.359%	9.490%	9.459%	9.504%	9.556%	9.622%	9.613%
100%	9.186%	9.186%	9.186%	9.186%	9.186%	9.186%	9.186%
Panel B: Rebalance Return Benefit Relative to No Rebalancing							
	Look Intervals in Market Days						
Rebalance Bands	250	125	60	20	10	5	1
0%	0.26%	0.19%	0.18%	0.07%	-0.05%	-0.29%	-2.32%
5%	0.27%	0.22%	0.19%	0.20%	0.21%	0.20%	0.19%
10%	0.30%	0.25%	0.27%	0.24%	0.27%	0.26%	0.24%
15%	0.29%	0.33%	0.33%	0.35%	0.35%	0.32%	0.31%
20%	0.31%	0.36%	0.38%	0.40%	0.45%	0.43%	0.50%
25%	0.17%	0.30%	0.27%	0.32%	0.37%	0.44%	0.43%
100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

The best three algorithms are shown in yellow. The bottom row is the no-rebalance case. The 25 percent band shown in green has more than 5 percent equity exposure drift.

sectionalized to provide sensitivities to various market conditions. We have rising, flat, volatile, and trending market conditions. The author believes that this 13-year period of daily data for five representative classes, with daily data with sectionalization, provides reasonable robustness to the conclusions.

Rebalance and tolerance bands. The rebalance band is expressed as a percentage of the target allocation. For example, suppose the allocation to an asset class is 20 percent, with a 10 percent rebalance band and a 5 percent tolerance band. Rebalancing would be required only if the class drifted outside the rebalance range of 18–22 percent. Since the tolerance band is 5 percent, it is adequate to bring the class to within 19–21 percent. It is not necessary to bring the class exactly to the target of 20 percent. This study assumes strategic rebalancing, which means that once the bands are set, they are not changed based on market projections. For our analysis we explore rebalance bands of 0, 5, 10, 15, 20, 25, and 100 percent.[1] The tolerance bands were assumed to be 50 percent of the rebalance bands.[2] The 100 percent band is equivalent to not rebalancing (or very rare rebalancing); the 0 percent band requires rebalancing to the target every time you look (calendar rebalancing).

Intervals. For each rebalance band setting, we looked at the portfolio composition at intervals of 1, 5, 10, 20, 60, 125, and 250 days. These are market days, not calendar days, so these intervals closely correspond to looking daily, weekly, biweekly, monthly, quarterly, semiannually, and annually. For emphasis we reiterate that at each interval we look at the portfolio, but conditionally rebalance only if one or more of the classes has strayed outside the rebalance band. Thus, we will be exploring results for 49 rebalancing algorithms (7 bands × 7 intervals) for each historical period considered.

Experiment. Each experiment goes as follows: Consider the five-year period 1992–1996. We start with a portfolio split among the asset classes using the prescribed allocations. For 20-day (monthly) analysis with 20 percent bands for the classes, for example, we use the daily historical price data to derive the 20-day asset class returns.

At the end of the first 20 market days, we inspect the allocations of the five asset classes to see if any class allocation is outside 20 percent of its target. If so, the class needs to be rebalanced.[3] This conditional rebalancing is repeated every 20 market days for the period under consideration. At the end of the period, we use the portfolio end-wealth to compute the geometric return. We repeat this for each of the 49 algorithms.[4]

Rolling periods. We varied the periods (five-year rolling, ten-year rolling) from 1992 to 2004 to assess the impact of market conditions on rebalancing benefits. Specifically, the nine 5-year periods we studied were 1992–1996, 1993–1997, 1994–1998, and so on until 2000–2004. The four 10-year rolling periods studied were 1992–2001, 1993–2002, 1994–2003, and 1995–2004. We also studied one 3-year shorter period 2002–2004 and the full 13-year period from 1992 to 2004.

Start-of-month averaging. In our initial experiments, we observed some anomalous results depending on the starting month. A January 1 start sometimes gave slightly different results from a March 1 start. To smooth these anomalies, we chose to average the results for the 12 first-of-the-month start dates for each experiment. We caution researchers that such 12-month averaging is needed to remove anomalous month-dependent variations in reporting results. Thus, we looked at 15 (rolling and overlapping) periods with 12 monthly starts for each of the 49 algorithms (15 × 12 = 180 data points for each of the 49 algorithms studied).

Trading costs. Consistent with current market trading costs for wealth managers, we assumed a flat trading cost ($20 a trade), independent of the size of the trade. This is in contrast to many prior studies with pension plans where trading is done using futures or blocks of many stocks, and costs are assumed to increase with the size of the trade. In some such studies (Masters 2002), the rebalancing bands were determined by considering the trade-off between rebalancing benefits and trading costs—a method that does not apply to the new flat-cost wealth manager's world. The baseline study assumed a $1 million portfolio (trading cost implications for different size portfolios are described later in the paper).

The remainder of the paper will examine the results of the baseline case, sensitivities to input parameters, practical guidelines for rebalancing, and tax sensitivities.

Table 2: Sensitivity of Rebalancing Benefits to Market Conditions

Panel A: Five-Year Trending Markets

Rebalance Bands	Look Intervals in Market Days						
94–98	250	125	60	20	10	5	1
0%	−0.45%	−0.51%	−0.50%	−0.65%	−0.84%	−1.08%	−3.16%
5%	−0.46%	−0.49%	−0.47%	−0.55%	−0.58%	−0.54%	−0.56%
10%	−0.43%	−0.48%	−0.40%	−0.48%	−0.48%	−0.50%	−0.50%
15%	−0.40%	−0.45%	−0.44%	−0.43%	−0.45%	−0.45%	−0.51%
20%	−0.36%	−0.35%	−0.38%	−0.29%	−0.35%	−0.30%	−0.25%
25%	−0.24%	−0.24%	−0.34%	−0.38%	−0.39%	−0.40%	−0.30%
100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Rebalance Bands	Look Intervals in Market Days						
00–04	250	125	60	20	10	5	1
0%	−0.21%	−0.36%	−0.42%	−0.49%	−0.61%	−0.83%	−2.76%
5%	−0.20%	−0.32%	−0.42%	−0.36%	−0.34%	−0.37%	−0.37%
10%	−0.16%	−0.30%	−0.29%	−0.31%	−0.29%	−0.23%	−0.21%
15%	−0.09%	−0.17%	−0.13%	−0.17%	−0.19%	−0.16%	−0.19%
20%	0.01%	0.01%	0.03%	0.02%	−0.02%	−0.01%	0.01%
25%	0.27%	0.20%	0.17%	0.20%	0.19%	0.18%	0.08%
100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Panel B: Five-Year Periods with At Least One Volatile Year

Rebalance Bands	Look Intervals in Market Days						
97–01	250	125	60	20	10	5	1
0%	0.54%	0.45%	0.57%	0.49%	0.31%	0.09%	−1.92%
5%	0.54%	0.46%	0.60%	0.63%	0.57%	0.60%	0.59%
10%	0.52%	0.52%	0.64%	0.69%	0.69%	0.75%	0.66%
15%	0.43%	0.61%	0.79%	0.85%	0.74%	0.76%	0.76%
20%	0.46%	0.58%	0.57%	0.92%	0.84%	0.94%	0.84%
25%	0.37%	0.55%	0.44%	0.45%	0.50%	0.77%	0.88%
100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Rebalance Bands	Look Intervals in Market Days						
99–03	250	125	60	20	10	5	1
0%	0.12%	0.03%	0.05%	−0.04%	−0.18%	−0.39%	−2.37%
5%	0.12%	0.06%	0.05%	0.13%	0.08%	0.08%	0.07%
10%	0.11%	0.09%	0.18%	0.21%	0.22%	0.27%	0.18%
15%	0.13%	0.14%	0.30%	0.24%	0.26%	0.21%	0.22%
20%	0.01%	0.13%	0.39%	0.41%	0.46%	0.47%	0.39%
25%	0.10%	0.15%	0.31%	0.31%	0.63%	0.65%	0.74%
100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

The best algorithms are show in yellow. The bottom row is the no-rebalance case. The 25 percent band shown in green has more than 5 percent equity exposure drift.

Continued on page 54

Results for Baseline Case

Return differences. For the 13-year baseline period 1992–2004, the 12-month averaged geometric returns for the 49 rebalance algorithms are shown in Table 1. The data are read as follows: For the rebalance case of 20 percent/60 days, for example, we look at the portfolio every 60 days and rebalance if an asset class drifts by more than 20 percent from its target. The geometric return of this rebalanced portfolio was found to be 9.566 percent. The last row in Panel A with 100 percent bands shows that the return with no rebalancing was 9.186 percent.

Thus, as shown in Panel B, the rebalance return benefit for the 20 percent/60 days case relative to the no-rebalancing case is 9.566% – 9.186% = 0.38%.

In the first part of our study, we will focus on these *return* differences as we change various parameters. A second benefit is the *risk control* provided by a rebalanced portfolio: the risk-adjusted benefits will be described in a later section.

Preliminary observations. Note that the first row for 0 percent bands in both panels corresponds to calendar rebalancing to the target. For 0 percent/20 days, we look at the portfolio every 20 days and rebalance classes that are off by even $.01 (that is, all classes). Not surprisingly, the rebalance return benefit shown in the first row of Table 1, Panel B, is very negative for daily rebalancing due to the associated large trading costs (even at $20 a trade). As the bands get wider, the rebalancing benefits increase, at least for the shorter intervals. However, for the widest band shown—25 percent—the benefits decrease.

Portfolio drift constraint. A practical constraint wealth managers must follow is that the portfolios not drift far from the IPS objective. To adhere to this requirement, we limit equity exposure drifts to 5 percent (for a 60 percent equity exposure drift up to 65 percent). Our study showed that the 0–20 percent bands stayed within this acceptable band, while the 25 percent band strays off by as much as 7 percent. Thus, while we show the 25 percent results, we will limit our quantitative comparisons to the 42 cases, excluding the 25 percent band results.

Highlight best algorithms. For each

Table 2: Sensitivity of Rebalancing Benefits to Market Conditions *(Continued)*

Panel C: Ten-Year Periods with At Least One Volatile Year

Rebalance Bands	Look Intervals in Market Days						
92–01	250	125	60	20	10	5	1
0%	0.21%	0.16%	0.18%	0.08%	−0.05%	−0.30%	−2.34%
5%	0.22%	0.18%	0.21%	0.21%	0.22%	0.21%	0.21%
10%	0.24%	0.22%	0.27%	0.25%	0.30%	0.29%	0.25%
15%	0.21%	0.25%	0.29%	0.35%	0.34%	0.34%	0.32%
20%	0.19%	0.26%	0.30%	0.32%	0.48%	0.43%	0.46%
25%	0.17%	0.23%	0.18%	0.19%	0.20%	0.30%	0.32%
100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Rebalance Bands	**Look Intervals in Market Days**						
94–03	250	125	60	20	10	5	1
0%	0.59%	0.53%	0.51%	0.39%	0.23%	0.01%	−2.01%
5%	0.59%	0.56%	0.53%	0.52%	0.49%	0.51%	0.51%
10%	0.60%	0.57%	0.64%	0.60%	0.59%	0.59%	0.56%
15%	0.62%	0.63%	0.71%	0.68%	0.66%	0.64%	0.61%
20%	0.60%	0.75%	0.67%	0.79%	0.79%	0.81%	0.83%
25%	0.57%	0.73%	0.73%	0.70%	0.70%	0.76%	0.77%
100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

The best algorithms are show in yellow. The bottom row is the no-rebalance case. The 25 percent band shown in green has more than 5 percent equity exposure drift.

period studied, we highlight the 12-month averaged algorithms that stand out as significantly better than the others. In this baseline case these are the 20 percent/one day, 20 percent/five days, and 20 percent/ten days algorithms. Will this trend persist as we change input parameters? Is there a basic reason for this apparent pattern? We address these questions in the following section.

Sensitivities to Historical Periods

The historical period studied from 1992 to 2004 exhibited a variety of market conditions, including trending bullish years in the early nineties, volatile bearish years after the turn of the century, and less volatile years in the last part of this period. We studied the sensitivity of rebalancing benefits to market conditions by inspecting 15 sectionalized and full periods from 1992 to 2004, as mentioned earlier. Due to space consideration, we will show only the detailed results for representative periods, and then show the average (and standard deviations) of the 15 periods considered.

In the five-year rolling period from 1994 to 1998 (Table 2, Panel A), which is characteristic of a strong upward trending bull market, rebalancing showed negative returns. The algorithms exhibiting the lowest return penalties were the 20 percent band with one-, five-, and ten-day intervals.

The 2000–2004 period in Table 2, Panel A, is characteristic of a strong persistent downward trending market in one class, namely U.S. large-cap stocks. Disciplined rebalancing consistently took monies from U.S. small cap and plowed it into U.S. large cap, resulting in the reduced returns. Even in such trending periods, the best performance was associated with 20 percent bands, but note that the interval chosen was not material. Similar results were observed for the three periods: 1992–1996, 1993–1997, and 1995–1999.

The remaining ten periods studied, some of them illustrated in Panels B and C of Table 2, included four 5-year periods, all four of the 10-year periods, the entire 13-year period, and the last three years from 2002 to 2004. These periods can be characterized as having at least one volatile year.

The results for these periods exhibited a very consistent pattern. The wider 20 percent bands and one-, five-, and ten-day frequent-looking rebalancing algorithms provide superior returns. The benefits decreased with the wider 25 percent bands; this is because with bands that are too wide, we miss many buy-low/sell-high opportunities.

Calendar rebalancing (0 percent band) and the narrower bands (5, 10, and 15 percent) do not fare well because we find ourselves rebalancing back to the target too soon, thereby curbing upward or downward trends in the classes.

We also observe that the algorithm results for 60, 125, and 250 days are consistently poorer than the one-, five-, and ten-day intervals. While we are preventing portfolio drift in these longer-interval algorithms, the likelihood of capturing sporadic buy-low/sell-high opportunities decreases.

Our observation is consistent with many studies that have shown little difference between quarterly, semiannual, and annual rebalancing. Impressively, we see that the benefits for the one-, five-, and ten-day intervals are significantly better than quarterly or longer interval rebalancing. The few prior studies (Buetow 2002 and Arnott 2002) on daily rebalancing corroborate these results.

The average of all the 15 periods considered is shown in Panel A of Table 3. Each number in this panel is the average of 180 samples (15 periods × 12 monthly starts). These averages emphasize our observations that more frequent looking and wider bands provide significant benefits over narrower-band, longer-interval strategies. (Table 3, Panel C, shows the average of four 10-year periods.) Note, however, that since these are averages of rolling periods, they will emphasize the middle years more than the tail years.

In particular we see that daily, weekly, or biweekly looking with 20 percent bands roughly doubles traditional annual rebalancing with 20 percent bands. We note that benefits increase as bands are widened, up to 20 percent, and that return

Table 3: Averages and 25th Percentile for Multiple Periods

Panel A: Averages of Rebalance Return Benefits; 15 Rolling Periods with 12 Monthly Starts

Rebalance Bands	Look Intervals in Market Days: 250	125	60	20	10	5	1
0%	0.13%	0.07%	0.08%	−0.02%	−0.16%	−0.40%	−2.44%
5%	0.13%	0.09%	0.11%	0.10%	0.10%	0.11%	0.09%
10%	0.15%	0.13%	0.18%	0.16%	0.19%	0.18%	0.16%
15%	0.15%	0.19%	0.23%	0.26%	0.25%	0.23%	0.22%
20%	0.16%	0.22%	0.25%	0.33%	0.38%	0.39%	0.38%
25%	0.14%	0.21%	0.21%	0.22%	0.27%	0.30%	0.35%
100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Panel B: 25th Percentile of Rebalance Benefits; 15 Rolling Periods with 12 Monthly Starts (180 Cases)

Rebalance Bands	Look Intervals in Market Days: 250	125	60	20	10	5	1
0%	0.01%	−0.06%	−0.02%	−0.07%	−0.21%	−0.45%	−2.47%
5%	0.01%	−0.04%	0.01%	0.05%	0.05%	0.05%	0.05%
10%	0.02%	0.00%	0.09%	0.10%	0.13%	0.12%	0.11%
15%	0.04%	0.06%	0.12%	0.18%	0.18%	0.16%	0.16%
20%	0.03%	0.07%	0.12%	0.20%	0.27%	0.29%	0.31%
25%	0.00%	0.05%	0.08%	0.12%	0.15%	0.19%	0.22%
100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Panel C: Average for Four 10-Year Periods

Rebalance Bands	Look Intervals in Market Days: 250	125	60	20	10	5	1
0%	0.32%	0.24%	0.30%	0.25%	0.10%	−0.13%	−2.15%
5%	0.32%	0.27%	0.33%	0.37%	0.36%	0.37%	0.37%
10%	0.34%	0.31%	0.41%	0.42%	0.44%	0.43%	0.42%
15%	0.36%	0.36%	0.42%	0.51%	0.48%	0.47%	0.47%
20%	0.32%	0.41%	0.43%	0.50%	0.59%	0.61%	0.62%
25%	0.25%	0.34%	0.41%	0.44%	0.42%	0.49%	0.48%
100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

The best three algorithms are shown in yellow. The bottom row is the no-rebalance case. The 25 percent band shown in green has more than 5 percent equity exposure drift.

benefits for the wider 20 percent band increases with the frequency of looking, up to biweekly looking.

To study the robustness of the data we also looked at the 25th percentile of the 180 samples as shown in Panel B of Table 3. More frequent looking is the most robust (shows the least spread over cases studied). In contrast, annual rebalancing shows marginal benefits. In some years (trending markets) this approach does well, but over a larger spread of market conditions, the return benefits of annual rebalancing are minimal. Risk control benefits of rebalancing are discussed in a later section.

Our results corroborate prior findings that rebalancing return benefits are negative in trending markets; that rebalancing provides return benefits in average and volatile markets; that quarterly, semiannual and annual rebalancing provides similar benefits; and that daily looking is significantly superior to quarterly or longer algorithms.

The new insight our data provides is that too narrow a band (0, 5, 10, 15 percent) curtail rebalancing benefits because it does not allow classes to ride the up or down trends. On the other hand, too wide a band (25 percent or higher) misses buy-sell opportunities. Our study strongly favors 20 percent bands, as can be seen from the plot of the results in Figure 3. A revelation from our study is that one does not need to go to the extreme of daily looking to capture these marked improvements; weekly and biweekly looking provides just as much in rebalancing benefits. This last observation has the following practical implication for wealth managers' operations: it is sufficient to cycle through all your clients over a two-week period to achieve maximum rebalancing benefits.

Risk control. Thus far we have studied only the return benefit of rebalancing versus not rebalancing. A second benefit of rebalancing is that it prevents increase in risk exposure.

To study this benefit, we did a Monte Carlo simulation for the un-rebalanced portfolio. The drifted un-rebalanced portfolio strays from the efficient frontier in two directions: vertically downward, corresponding to the return degeneration we have studied, and horizontally, reflecting volatility changes.

Our simulations showed that the average increase in the standard deviation for the 180 cases studied was 0.48 percent. From a risk/return trade-off perspective, this increase in volatility is equivalent to a decrease in return. In particular, assuming a linear slope of the efficient frontier for this portfolio, this increase in volatility is equivalent to a decrease in return of 0.16 percent (slope equals 3.0; equivalent return penalty equals standard deviation shift divided by slope). Thus, the volatility-adjusted rebalancing benefits can be approximated by adding this return correction to the rebalanced return benefits in Panel A and Panel C of Table 3.

We thus see that for our data, the daily, weekly, and biweekly volatility-adjusted rebalancing benefit is approximately 55 basis points (bps) more than with no rebalancing. This is 22 bps better than annual rebalancing with 20 percent bands, and 25 bps better than calendar rebalancing to the benchmark.

A further intuitive observation from the study is that average rebalancing benefits are higher for longer periods than for shorter periods (as illustrated in the bottom of Table 3). This is because longer periods are likely to have more volatile years where rebalancing benefits most. The average rebalancing benefit over not rebalancing for the four 10-year periods 1992–2001, 1993–2002, 1994–2003, and 1995–2004 was 62 bps for biweekly looking with 20 percent bands. The volatility-adjusted benefit for 20 percent biweekly looking is 62 + 16 = 78 bps; this is 30 bps greater than annual rebalancing with 20 percent bands.

Later in this paper we will show that trading costs and tax costs are significantly smaller than these benefits—put another way, rebalancing far outweighs tax and trading cost considerations.

The Shuffle Experiment

In this section we describe the "shuffle" experiment to gain further insight into the source of the observed rebalance benefits. In this experiment we reordered (shuffled) the returns of the five asset class sets randomly for the 1992–2004 period.

Shuffling is illustrated as follows: suppose that for the 20-day (monthly) algorithms, the returns for the five classes for the second period, February 1992, were 2 percent, 1, –1, 3, and –2 percent. After the shuffle, this set of returns (as a combined group) could shift to the 43rd, 107th, or any other random period. The shuffle changes the ordering but does not change the raw data for the classes; thus, the means, standard deviations, and cross correlations of the shuffled data are exactly the same as the original data.

If these three parameters were sufficient to fully characterize the data for rebalancing purposes, the rebalance benefits should remain unchanged before and after the shuffle. Surprisingly, we found that the benefits of frequent looking entirely disappear after the shuffle (Table 4). Daily, weekly, and biweekly benefits are essentially the same as longer interval benefits!

This leads us to the conclusion that factors other than means, standard deviations, and cross correlations must be accounting for the frequent-look benefits. The observation that shuffling removes non-random correlations in day-to-day returns leads us to the postulate that such serial correlations within the asset classes or cross-serial correlations among the classes must be accounting for the observed benefits.

Other terms sometimes used to describe serial correlation are autocorrelation or momentum (for positive autocorrelation) and mean reversion (for negative autocorrelation). Further data analyses showed that such serial correlations in the source data were sporadic, meaning sometimes serial correlation is there and sometimes not. This sporadic occurrence of serial correlation is also referred to as non-stationary autocorrelation.

Our thesis is that the increased benefits of frequent looking are attributable to these transient momentum and reversion occurrences that occur sporadically in historical data. The reason wider bands provide a greater benefit is that we permit the momentum to take classes to higher (or lower) levels before rebalancing. Narrower bands choke these momentum drifts.

While these occurrences may not be not predictable, strategic rebalancing does not require us to know *when* they occur, but only depends on the fact that they *do* occur. As long as we look frequently we will capture and benefit from sporadic momentum and reversion.

The shuffle experiment corroborates the conclusion that non-stationary momentum

Figure 3: Average Rebalance Benefit Versus Interval in Days for Looking

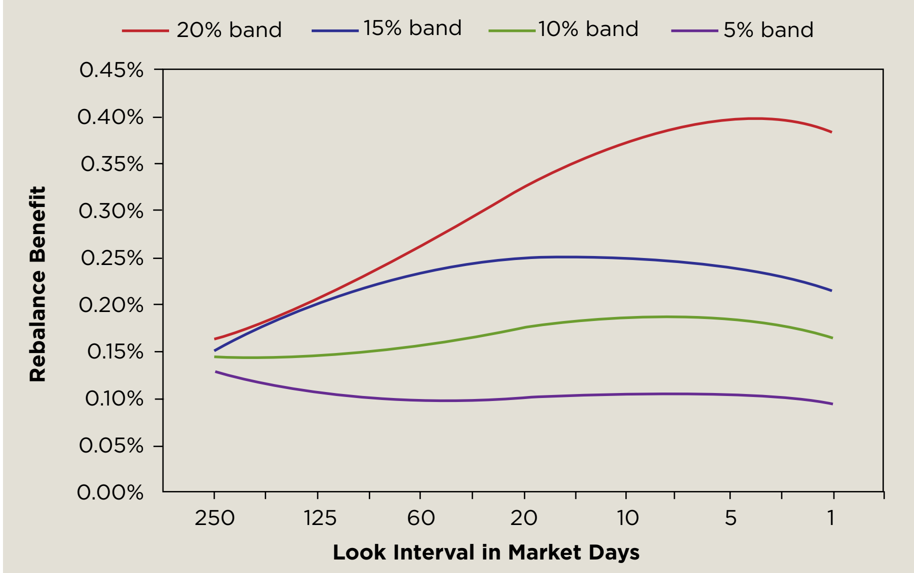


Table 4: Rebalance Return Benefits for Shuffle Experiment

Rebalance Bands	Look Intervals in Market Days: 250	125	60	20	10	5	1
0%	0.15%	0.10%	0.06%	–0.01%	–0.12%	–0.37%	–2.39%
5%	0.16%	0.11%	0.09%	0.08%	0.09%	0.08%	0.06%
10%	0.17%	0.13%	0.12%	0.11%	0.11%	0.12%	0.11%
15%	0.17%	0.16%	0.15%	0.16%	0.14%	0.16%	0.15%
20%	0.17%	0.20%	0.17%	0.18%	0.18%	0.18%	0.16%
25%	0.19%	0.17%	0.18%	0.19%	0.20%	0.20%	0.19%
100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

The best algorithms are shown in yellow.

Table 5: Average Classes Requiring Rebalancing Per Year

	Look Intervals in Market Days						
Rebalance Bands	250	125	60	20	10	5	1
0%	5	10	20	60	120	239	1196
5%	5	7	11	17	22	27	34
10%	3	4	5	7	8	9	10
15%	2	3	3	4	4	4	5
20%	1	2	2	2	3	3	3
25%	1	1	1	1	2	2	2
100%	0	0	0	0	0	0	0

The bottom row is the no-rebalance case. The 25 percent band shown in green has more than 5 percent equity exposure drift.
Average trades generated per year, assuming one trade needed for rebalancing an asset class. Average for 15 rolling periods, 12 monthly starts.

and reversion do occur in historical data, and that the market is not totally efficient. Strategic rebalancing with wider bands and frequent looking, which we've called "opportunistic rebalancing," is a way of capturing alpha and increasing returns from this fundamental phenomenon.

Even in the shuffled data there is a residual-return rebalancing benefit of approximately 17 bps. This also appears for longer quarterly and annual rebalancing algorithms. This residual benefit can be attributed to the control of longer-term return drift which keeps the portfolio near the starting optimal point on the efficient frontier.

Our data suggest that, of the total 55 bps rebalancing benefit, controlling long-term drift return provides a 17 bps benefit, containing long-term drift volatility provides 16 bps benefit, and frequent looking with wider bands to capture short-term momentum and reversion effects provides an additional 22 bps return benefit.

The return and volatility drifts appear to be slow, so they can be controlled with quarterly or even annual rebalancing. The additional benefit coming from short-term momentum and reversion occurrences is transient with unpredictable timing, so one must look frequently to get these benefits.

We therefore conclude that looking frequently will provide additional benefits over the commonly used quarterly or annual rebalancing. The extra benefit comes about because frequent looking captures return benefits associated with short-term buy-low/sell-high opportunities. Quarterly or annual rebalancing will often miss these short-term opportunities.

Costs of Rebalancing

When rebalancing, there essentially are three costs: trading costs and tax costs for the client, and operational costs for the wealth manager. We will look into each of these.

Trading costs. The average number of classes requiring rebalancing per year for each of the 49 algorithms (for all 180 cases: 15 periods × 12 monthly starts) is shown in Table 5. Recall that we only trade asset classes that are out of balance but will trade an in-band class if necessary to balance buys and sells.

Our analyses assumed that one fund is traded each time a class requires rebalancing, with a flat cost of $20, independent of the size of the trade. These trading costs are included in the returns stated in the rebalance benefit tables.

As expected, daily calendar rebalancing requires the largest number of trades since every class is rebalanced every day, and the no-rebalancing (100 percent band) cases did not incur any trades.

Note that the numbers of trades per year decreases as the bands are widened and increases slightly as the look frequency increases. Interestingly, our favorite wider bands with frequent looking only incurred an average of two to three trades a year, which is even less than a systematic quarterly rebalancing.

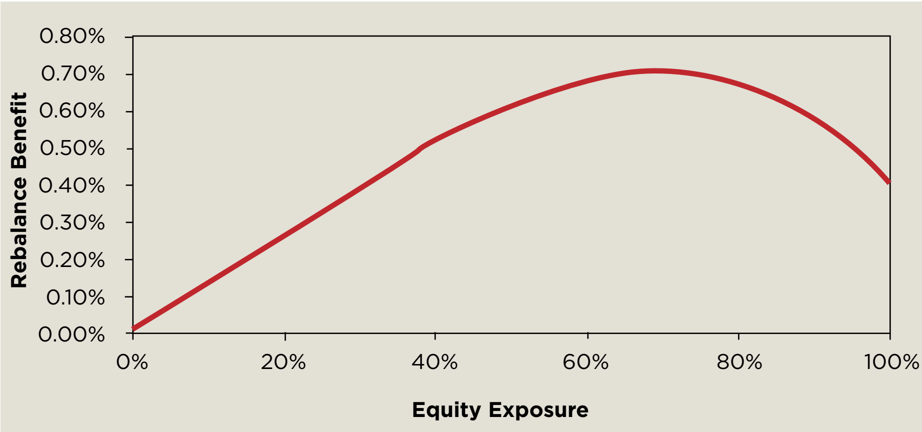
To get a calibration on trading costs relative to the rebalancing benefits, let us consider the following example. Suppose three classes required rebalancing in a year and each class correction required us to trade one fund per asset class. With a flat cost of $20 a trade, the total trading cost would be $60. On a $1 million account this translates to 0.6 bps. This is a small percentage of our observed rebalancing benefits of 55 bps,[5] though in smaller (larger) portfolios the trading cost would have a proportionally larger (smaller) impact.

We conclude that in a world with such current low trading costs, which are trending downward, wealth managers should not let trading costs be a significant driver in the selection of rebalancing algorithm. Trading costs will be much less than 5 percent of the rebalance benefits.

Tax costs. If an asset class needs to be sold, and we have a choice, it certainly makes sense to sell securities in that class from a tax-deferred account rather than a taxable account if gains will be realized in the taxable account. Conversely, sell these securities from the taxable account if losses can be garnered. The significance of tax costs relative to rebalancing benefits can be assessed as follows.

An asset class has risen in value and is now overweighted, and suppose rebalancing it requires selling $100,000 of a security from a taxable account. Suppose also that the long-term gain on this security is $25,000, which would realize a tax of $5,000, assuming 15 percent capital gains and 5 percent state tax rates. For a $1 million client, $5,000 translates to 50 bps. Is the net cost to the client 50 bps? Not really, as the realization of gains also increases the basis of the security and that needs to be folded into the total cost to the client. The annualized net cost to the client is the opportunity cost of investing the $5,000. If one assumes an annual after-tax return of 4 percent, the cost to the client is $200 (4 percent of $5,000), or 2.0 bps a year, which will most likely be significantly less than

Figure 4: Rebalance Benefit Versus Equity Exposure 1995–2004 Biweekly



expected rebalancing benefits, and rebalancing will win. The key point we are making is that from an end-wealth perspective, rebalancing benefits need to be compared not with the costs associated with *realizing* taxes, but rather with the much lower cost of not *deferring* taxes.

We have repeated these experiments in taxable accounts and have found that the tax-deferral penalties incurred due to rebalancing in a taxable account are in the range of 5 bps. This study has not been included due to space limitations. These tax costs are less than 10 percent of the rebalance benefits of 55 bps.

But reasons other than end-wealth sometimes dictate wealth mangers' counsel: clients may have a different perspective on the immediate payment of taxes, and that subjective consideration may induce wealth managers to take the risk of not rebalancing an overweighted class, which all too often also may translate to the risk of losing principal. Note that tax-loss harvesting does offset taxes on gains and should be pursued aggressively as these opportunities present themselves.

In summary, an end-wealth analysis should compare rebalancing benefits with the cost of not deferring taxes (*not* with the cost of realizing taxes). Based on the results discussed above, rebalancing benefits will far exceed the benefits obtained from deferring the taxes on the realization of gains.

Operational costs. Even if you don't trade frequently, our recommended biweekly looking could potentially increase a wealth manager's operations costs. This is the primary cost associated with the new paradigm of frequent looking/trading less.

From a practice perspective, there are two components to rebalancing human capital. The first is looking to check if the asset classes are out of balance (looking cost). The second cost is that of correcting the out-of-rebalance classes (rebalancing trade-generation costs).

Our suggested approach results in two to three rebalancing events a year incurring trading costs, which is not significantly different from quarterly rebalancing trade-generation costs. The suggested method differs in that these events may be unscheduled, and that there needs to be a process in place to identify the buy-low/sell-high opportunities.

The looking cost associated with frequent looking is definitely higher than with quarterly rebalancing. But practitioners who use portfolio management systems may be able to readily look for out-of-balance portfolios with relatively little effort. For advisors charging fees based on assets under management, the additional fees generated from the extra returns associated with looking frequently should more than cover these additional costs.

Further, net cost reductions can be achieved by incorporating available software technologies that automate the looking and the trade-generation processes.

Practical Guidelines

In this section we will comment on practice management guidelines that may be useful to wealth managers. Some of these guidelines come from our analyses; others are based on discussions with leading wealth management firms.

Asset classes, sub-classes, and bands. The majority of wealth managers follow modern portfolio theory and organize their clients' portfolios in classes and sub-classes, and have a buy list of funds (or other securities) for each sub-class. The survey conducted with the Financial Planning Association in 2005 suggests that most planners use 6 to 13 classes. Rebalancing benefits can be increased by using more uncorrelated classes, to increase the number of buy-low/sell-high opportunities. In contrast, the move to lump a number of equity classes into a core holding (for the purpose of reducing trading costs or gaining tax deferrals) is contrary to our studies, which show that rebalancing benefits swamp these costs.

Our study of sensitivity of rebalancing benefits to equity exposure corroborates these conclusions. Figure 4 shows these results for the period 1995–2004. With 100 percent equity exposure, the bond exposure is 0 percent, the number of asset classes reduces to four, and rebalance benefits decrease. Part of the reduction is also attributed to the fact that these four asset classes have a stronger cross correlation. To the other extreme, with 0 percent equity exposure, we are reduced to one asset class and of course there is no rebalancing benefit. Further studies are warranted on rebalancing benefits versus number of classes with different correlations.

We postulate that rebalancing benefits will increase as we increase the number of uncorrelated asset classes and as the volatility of these classes increases. We believe our five asset-class results establish a lower reasonable bound to rebalancing benefits.

Asset location. Most clients have multiple accounts. To maximize benefits from asset location, wealth managers will take the trouble to place high-return inefficient classes in tax-deferred accounts and high-return efficient classes in taxable accounts.

Daryanani and Cordaro (January 2005) showed that the location of low-return classes (such as short-term bonds) does not make much difference to after-tax end wealth. They also demonstrated optimal location provides an average 30 bps improvements in returns compared with a pro-rata distribution of asset classes among the account types.

The survey with the FPA of 100 planners suggests that almost 60 percent of planners locate asset classes with tax efficiency in mind, despite the consequent difficulties of rebalancing. The operational cost of this superior location strategy is significant in that rebalancing across a family of accounts is much more complicated.

Yet significant benefits can be achieved with optimal location combined with opportunistic rebalancing (30 bps from location and 50 bps to 80 bps from rebalancing, depending on the period considered). The trading and tax costs of rebalancing are significantly less than the benefits derived.

Future Research

While our studies explored the 1992–2004 period in many ways, we see the need for further research to correlate rebalance benefits with the choice and number of asset classes and with characteristics of historical periods.

Further, we encourage additional research using Monte Carlo simulations, which is not trivial in that non-stationary serial correlations must be incorporated for these to be meaningful; we know of no such exhaustive studies to date. This additional research will further advance our understanding of the fundamental factors that contribute to rebalancing benefits for multi-class portfolios. We may see ways of advancing rebalancing to tactical rebalancing based on other controlling parameters and market conditions.

We believe we have only just started scratching the surface of the potential benefits from rebalancing. Certainly we expect vendors to provide tools to offset the costs of human resources required for more complex rebalancing algorithms. There is much room for collaborative research in rebalancing.

Conclusions

We have shown significant advantages of opportunistic rebalancing (look frequently and rebalance only when you need to) over traditional annual or quarterly rebalancing. Opportunistic rebalancing goes beyond simply controlling risk; it also increases return benefits by capturing sporadic buy-low/sell-high opportunities. The benefits from opportunistic rebalancing far outweigh the costs associated with trading, taxes, and looking. Look frequently and trade less to maximize your rebalance benefits.

JFP

Endnotes

1. We discourage the use of absolute bands (such as 5 percent of the portfolio) for all asset classes since this tends to under-correct lower allocation classes and over-correct higher allocation classes.
2. Although in this study we used a tolerance band of 50 percent of the rebalance band, the author has found the results to be relatively insensitive to tolerance bands between 25 percent and 75 percent.
3. We may need to touch one other class with a purchase or sale to ensure that we do not go into margin or generate excess cash.
4. The results were arrived at by using an Excel program with VBA code to run multiple cases in each experiment. The VBA code was written to loop the number of days for each rebalance band. This involved 49 iterations for each experiment (7 intervals for each of 7 tolerance bands).
5. More than one trade may be needed to rebalance an asset class, depending on the number of funds (securities) used for its implementation. But even with as many as four funds per asset class, the trading cost would only increase to 2.4 bps per year.

References

Arnott, Robert and Robert Lovell, Jr. 1993. "Rebalancing: Why? When? How Often?" *The Journal of Investing* 2.

Buetow, Gerald. 2002. "The Benefits of Rebalancing." *Journal of Portfolio Management* Winter.

Daryanani, Gobind and Chris Cordaro. 2005. "Asset Location: A Generic Framework for Maximizing After-Tax Wealth." *Journal of Financial Planning* 18, 1 (January): 44–54.

Financial Planning Association. Survey on rebalancing conducted for FPA's 2005 annual conference, San Diego, CA.

Goodsall, Bill and Lisa Plaxo. 1994. "Rebalancing to Benchmark." First Quadrant Corporation. *Investment Management Reflections.*

Goodsall, Bill and Lisa Plaxo. 1996. "Tactical Rebalancing." First Quadrant Corporation. *Investment Management Reflections* No. 3.

Masters, Seth J. 2002. "Rules in Rebalancing." http://www.financial-planning.com/pubs/fp/20021201018.html.

Miccolis, Jerry. 2005. "Rebalancing Act." Research Brief No. 0502 (June): www.brintoneaton.com.

Plaxo, Lisa and Robert Arnott. 2002. "Rebalancing a Global Policy Benchmark." *Journal of Portfolio Management* Winter.

Tsai, Cindy Sin-Yi. 2001. "Rebalancing Diversified Portfolios of Various Risk Profiles." *Journal of Financial Planning* 14, 10 (Oct): 104–110.

TD AMERITRADE Institutional
1 Plaza Four A
Jersey City, NJ 07311
800-934-6124

42750