Portfolio Rebalancing in Theory and Practice

Number 31

Vanguard® Investment Counseling & Research

Author

Yesim Tokat, Ph.D.

Executive summary

A portfolio's asset allocation determines the portfolio's risk and return characteristics. Over time, as different asset classes produce different returns, the portfolio's asset allocation changes. To recapture the portfolio's original risk and return characteristics, the portfolio must be rebalanced to its original asset allocation.

This paper identifies the factors that influence a rebalancing strategy. We present a conceptual framework for developing rebalancing strategies that can accommodate changes in the financial market environment and in asset class characteristics, as well as account for an institution's unique risk tolerance and time horizon. Our findings indicate that:

- Determining an effective rebalancing strategy is a function of the portfolio's assets: their expected returns, their volatility, and the correlation of their returns. For example, a high correlation among the returns of a portfolio's assets means that they tend to move together, which will tend to reduce the need for rebalancing. In addition, the investment time horizon affects the rebalancing strategy. A portfolio with a short time horizon is less likely to need rebalancing because there is less time for the portfolio to drift from the target asset allocation. In addition, such a portfolio is less likely to recover the trading costs of rebalancing.

- The effect of a rebalancing strategy on a portfolio depends on return patterns over time. If security prices approximately follow a random-walk pattern,[1] then rebalancing more frequently or within tighter bands reduces a portfolio's downside risk (absolute as well as relative to the target asset allocation). In a trending or mean-reverting market, the impact of rebalancing may be somewhat different when viewed on an absolute or relative-to-target basis.
- Additional factors to consider when implementing a rebalancing strategy include preference and costs, such as time spent, redemption fees, or trading costs. Each cost incurred will reduce the return of the portfolio. The nature and magnitude of trading costs affect the choice of rebalancing strategies.
- Due to differing risk tolerances, two institutions with identical asset allocations may prefer different rebalancing strategies.

Introduction

Portfolio rebalancing is a powerful risk-control strategy. Over time, as a portfolio's different investments produce different returns, the portfolio drifts from its target asset allocation, acquiring risk and return characteristics that may be inconsistent with an investor's goals and preferences. A rebalancing strategy addresses this risk by formalizing guidelines about how frequently the portfolio should be monitored, how far an asset allocation can deviate from its target before it's rebalanced, and whether periodic rebalancing should restore a portfolio to its target or to some intermediate allocation.

Although these general decisions apply to all rebalancing strategies, the specific guidelines appropriate to a particular portfolio may be unique. Because each guideline has an impact on the portfolio's risk and return characteristics, the *how often*, *how far,* and *how much* are partly questions of investor preference.

This paper establishes a theoretical framework for developing a portfolio-rebalancing strategy. We start by exploring the trade-off between various rebalancing decisions and a portfolio's risk and return characteristics. In theory, investors select a rebalancing strategy that balances their willingness to assume risk against returns net of the cost of rebalancing. We also explore a second important determinant of the appropriate rebalancing strategy—the characteristics of the portfolio's assets. For example, high correlation among the returns of a portfolio's various assets reduces the risk that the portfolio will drift from its target allocation, thus limiting the need to rebalance.

We conduct simulations to analyze how these different factors and different rebalancing guidelines affect a portfolio's risk and return characteristics. Our simulations explore a range of return patterns—trending, mean-reverting, and random walk—to illustrate the impact of different rebalancing guidelines in different market environments. We conclude with a review of practical rebalancing considerations. Although we encourage rebalancing for risk control, our analysis can also be used to build a framework for tactical rebalancing.

1 When prices follow a random-walk pattern, market prices follow a random path up and down, without any influence by past price movements, making it impossible to predict with any accuracy which direction the market will move at any point.

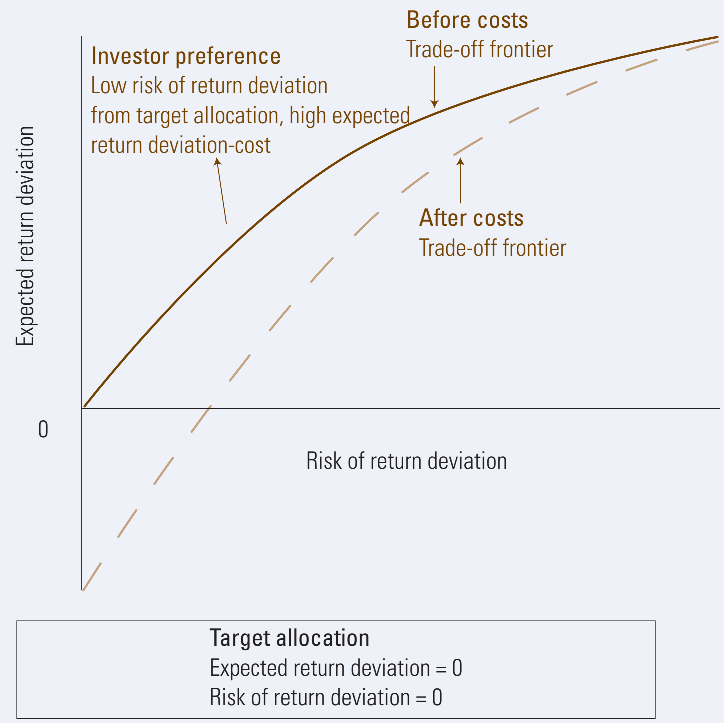
Trade-offs in the rebalancing decision

Like the selection of a portfolio's target asset allocation, a rebalancing strategy involves a trade-off between risk and return. In asset allocation, risk and return are absolutes. For instance, an expected annual return of 10% might be associated with annualized volatility of 15%, while a return of 5% might be associated with volatility of 7%. In a rebalancing strategy, by contrast, risk and return are measured relative to the performance of the target asset allocation (Leland, 1999; Pliska and Suzuki, 2004). The decisions that determine the difference between an actual portfolio's performance and that of the portfolio's target asset allocation include how frequently the portfolio is monitored, what degree of deviation from the target allocation triggers the rebalancing, and whether a portfolio is rebalanced to its target or to an intermediate allocation.

If a portfolio is never rebalanced, it will gradually drift from its target asset allocation to higher-return, higher-risk assets. Compared with the target allocation, the portfolio's expected return increases, as does its vulnerability to deviations from the return of the target asset allocation. This trade-off, which can be thought of as the rebalancing frontier, is depicted in Figure 1.

Consider a portfolio with a target asset allocation of 60% stocks and 40% bonds that is never rebalanced. Because stocks have historically outperformed bonds, the portfolio's asset allocation gradually drifts to 90% stocks and 10% bonds. As the portfolio's equity exposure increases, the portfolio moves toward the upper-right end of the rebalancing frontier—higher risk and higher return.

Figure 1. Hypothetical Rebalancing Trade-Off Relative to a Target Asset Allocation



The rebalancing frontier can be adapted to account for the costs of rebalancing—transaction costs, taxes, and time and labor costs—which diminish the portfolio's return. As the portfolio is rebalanced more frequently, costs become a bigger drag on performance. This relationship is depicted in Figure 1 by the sharp downward slope in the rebalancing frontier represented by the dashed line. At the upper-right end of the frontier, the low frequency of rebalancing imposes minimal costs. At the highly risk-controlled lower-left end of the frontier, rebalancing costs can be a significant burden. We present a detailed analysis of the impact of costs on the rebalancing frontier in "The impact of rebalancing costs on rebalancing strategy" on page 10.

Just as there is no universally optimal asset allocation, there is no universally optimal rebalancing strategy. An institution selects a rebalancing strategy based on its tolerance for risk relative to a target allocation. Because institutional preferences are unique, the rebalancing strategies that portfolio managers choose from the rebalancing frontier may differ. For example, some institutions may satisfy their risk preferences by monitoring their portfolios at an annual frequency and then rebalancing if the allocation shifts more than 10%. Other managers may want tighter risk control and choose to monitor their portfolios monthly, rebalancing if the allocation drifts by more than 1%.

Asset characteristics and the rebalancing decision

The development of a rebalancing strategy that is consistent with an institution's preferences also depends on the characteristics of a portfolio's assets. A rebalancing strategy that maintains an appropriate level of risk control in a portfolio of stocks and bonds may not be appropriate in a portfolio made up of hedge funds, real estate, and commodities.

As formalized by Stanley R. Pliska and Kiyoshi Suzuki (2004), the asset class characteristics that influence the rebalancing strategy include the following:

- Correlation: High correlation among the returns of asset classes means that they tend to move together. When the returns of all the assets in the portfolio move in the same direction, the asset allocation weightings tend to remain unchanged, reducing both the risk of significant deviation from the target allocation and the need to rebalance.
- Volatility: High return volatility increases the fluctuation of the asset class weightings around the target allocation and increases the risk of significant deviation from the target. Greater volatility implies a greater need to rebalance. In the presence of time-varying volatility, rebalancing occurs more often when volatility rises.
- Expected return: A high expected return for a particular asset causes a portfolio's allocation to drift toward this asset class more quickly. Significant differences among the expected returns of portfolio holdings increase the risk of significant deviation from the target allocation and thus increase the need to rebalance.
- Time horizon: A long time horizon increases the likelihood of a portfolio drifting from its target allocation, which produces a greater risk of significant return deviation. This long-term drift increases the need to rebalance. There is also more time to recover any costs of rebalancing. For a portfolio with a finite time horizon, in the presence of costly rebalancing, the optimal rebalancing frequency declines as the terminal investment date approaches (Liu and Loewenstein, 2002; Zakamouline, 2002).

Market environments and rebalancing results

A portfolio's return relative to its target asset allocation is the appropriate framework for evaluating a rebalancing strategy's effectiveness at risk control. However, real-world experience indicates that investors often view risk in absolute terms. In most market environments, where returns follow a random-walk pattern, successful relative risk control also reduces absolute risk. However, in some market environments, successful relative risk control can increase absolute risk. We examine market environments in which this disjunction between theory and perception is likely to be most pronounced.

We conduct simulations to identify return patterns in which rebalancing strategies and the decision not to rebalance produce the greatest discrepancies between *relative* and *absolute* performance.[2] If forewarned is forearmed, then a simple acknowledgment of these eventualities (which are always visible in retrospect, but rarely in advance) can help an institution maintain a disciplined rebalancing strategy through challenging market environments. We simulate rebalancing strategies with reasonable ad hoc monitoring frequencies and a 5% rebalancing threshold.[3] We rebalance to the target asset allocation, which is 60% stocks and 40% bonds. (See "Simulation details" on page 5.)

2 Absolute performance is the total return on the portfolio. Relative performance is the performance difference between the portfolio and its target asset allocation.

3 When a portfolio has a 5% rebalancing threshold, the portfolio is rebalanced if its allocation deviates 5% or more from the target asset allocation.

Simulation details

Monte Carlo simulation allows us to capture the uncertain nature of asset returns by calculating the probability distributions of many different potential returns. We randomly generated 1,000 normally distributed, realistic future 40-year (or 480-month) return-path scenarios based on monthly means, variances, and the correlation of U.S. stocks and bonds from 1960 to 2003. By assuming that the 60% equity/40% bond portfolio would follow a given rebalancing strategy throughout the 40-year investment horizon, we calculated the portfolio's risk and return characteristics for a given path. We repeated this for all 1,000 return paths and reported the average across all scenarios as the turnover, number of rebalancing events, and expected return and risk of the portfolio, under the given rebalancing rule.

Table 1. Portfolio Rebalancing Strategies in Trending and Mean-Reverting Markets

	Trending			Mean Reverting		
Monitoring frequency	Annually	Quarterly	Monthly	Annually	Quarterly	Monthly
Threshold	5%	5%	5%	5%	5%	5%
Average equity allocation	60.199%	60.150%	60.129%	61.816%	61.408%	61.250%
Costs of rebalancing						
Annual turnover	6.909%	7.327%	7.310%	0.645%	0.675%	0.684%
Number of rebalancing events	24.609	43.439	51.374	4.416	4.946	5.181
Absolute framework						
Average return	12.056%	10.946%	10.711%	9.354%	9.349%	9.346%
Volatility	24.001%	23.827%	23.806%	3.903%	3.901%	3.901%
Worst 12-month return	–37.334%	–40.286%	–40.730%	–3.456%	–3.461%	–3.462%
Relative framework						
Average excess return	2.037%	0.927%	0.692%	–0.187%	–0.193%	–0.195%
Volatility of excess return	2.462%	0.719%	0.455%	0.183%	0.171%	0.167%
Worst 12-month excess return	–1.077%	–0.541%	–0.507%	–1.429%	–1.381%	–1.373%

Notes: Average return, volatility, and correlation are based on historical returns from 1960 to 2003. Stocks are represented by the Standard & Poor's 500 Index Monthly Dividend Reinvest (1960–1970) and by the Dow Jones Wilshire 5000 Composite Index (1971–2003). Bonds are represented by the Lehman Brothers Corporate Bond Index (1960–1972), Lehman Government/Credit Index (1973–1975), and Lehman Aggregate Bond Index (1976–2003). There were no new contributions or withdrawals. Dividend payments were reinvested in equities; interest payments were reinvested in bonds. There were no taxes. All simulations used the same monthly average returns, correlations, and volatilities. The annual statistics were different, based on the imposed serial-correlation behavior. All statistics were annualized.

The performance data shown represent past performance, which is not a guarantee of future resutls. Investment returns will fluctuate. This hypothetical illustration does not represent the return on any particular investment.

Sources: Standard & Poor's, Dow Jones, and Lehman Brothers; author's calculations.

Trending markets

In trending markets, rebalancing can test an institution's or individual investor's resolve. If equity prices rise every period, regular rebalancing implies continually selling the strongly performing asset and investing in the weaker performer. The result is a lower return compared with a less frequently rebalanced portfolio. The U.S. stock market's steady upward surge during the mid- to late-1990s was an example of a trending market. Rebalancing produced lower returns than a portfolio that was never rebalanced.

The two-and-a-half years following the U.S. stock market's March 2000 peak were an example of a downward-trending market, again an environment that made rebalancing unattractive. If stock prices fall every period, then the portfolio is continually buying equities as their prices decline, experiencing returns below those of a portfolio that is never rebalanced.

To illustrate the performance of a rebalancing strategy in trending markets, we simulate a *strongly trending* equity market (serial correlation of 90%) over the 40-year investment horizon. It should be noted that serial correlation of 90% is an extreme manifestation of trending. We choose this exaggerated figure to highlight the differences between rebalanced and never-rebalanced portfolios.

Our simulations indicate that the more frequently a portfolio is rebalanced, the tighter its risk control relative to the target asset allocation, even during periods of strong price momentum. This tighter risk control is accompanied by the higher potential cost of rebalancing, as indicated by the greater number of rebalancing events and the higher turnover rate. This finding is consistent with our theoretical framework.

Table 1 on page 5 indicates that a portfolio's expected-return deviation and risk-of-return deviation declined as the portfolio was rebalanced more frequently. In a portfolio that was rebalanced annually, the volatility of excess return was 2.462%. When the portfolio was rebalanced monthly, this figure declined to 0.455%. The less frequently rebalanced portfolio also sustained a larger maximum 12-month loss relative to the target allocation.

In a trending market, a potentially troubling paradox was that tight relative risk control increased a portfolio's absolute risk. As the portfolio was rebalanced more frequently, its average return decreased. The most frequently rebalanced portfolio also produced the worst *absolute* return—the result of continually buying equities as their returns fell in a downward-trending market.

Mean-reverting markets

The opposite of a trending market is a mean-reverting market. Price increases are followed by price declines, and vice versa. In a mean-reverting market, a portfolio's returns can be enhanced by rebalancing, buying an asset after it has decreased in value and selling it after it has appreciated. In 1987 and 1988, the stock market followed a pattern of mean reversion. Stock prices rallied through much of 1987, collapsed on October 19, then recovered in a back-and-forth pattern during 1988.

Our simulation assumes an exaggerated level of mean reversion (serial correlation of –90%) to highlight the impact of different rebalancing strategies in a mean-reverting market. As was the case in a trending market, the more frequently rebalanced portfolio had tighter risk control relative to the target asset allocation. In a portfolio that was rebalanced monthly, the volatility of excess return was 0.167%, as displayed in Table 1. In a portfolio that was rebalanced annually, this figure rose modestly to 0.183%. The less frequently rebalanced portfolio also sustained a greater maximum 12-month loss relative to its benchmark.

Although a portfolio's buy-and-sell decisions are generally well timed when rebalancing in a mean-reverting market, our simulation indicated that as a portfolio was rebalanced more frequently, or within tighter bands, its *absolute* average return decreased. The additional return produced by well-timed purchases and sales was less than the additional return produced by the higher equity allocation in a less frequently rebalanced portfolio.

Risk differences among the different portfolios were relatively modest. The small scale of differences in this simulation was partly due to the low standard deviation of all portfolio returns in mean-reverting markets. When each upward or downward price movement was followed by its opposite, a portfolio's fluctuation around its average return tended to be modest. For example, in a trending market, the annualized standard deviation of a portfolio that was rebalanced annually was 24.001%. In the mean-reverting market, a portfolio with this same rebalancing strategy had a standard deviation of 3.903%.

Interpretations of rebalancing data in trending and mean-reverting markets

In certain market environments, rebalancing produces superior risk control but inferior returns. This disjunction can challenge an institution's commitment to rebalancing. It's important to recognize, however, that whether the prospective market environment will be trending or mean-reverting is rarely clear in advance. Rebalancing's risk-control benefits, by contrast, are a certainty. Commitment to a long-term rebalancing strategy requires absolute clarity about the institution's goals and risk tolerance, as well as the simple recognition that rebalancing will at times produce inferior returns.

An alternative interpretation of our simulation results is that managers who can predict return patterns can rebalance tactically to increase a portfolio's return and reduce the portfolio's risk. Although there is weak evidence for short-term trending and long-term mean-reverting in equity markets, both practical and academic evidence show that this predictability is very hard to exploit (Campbell, Lo, and MacKinlay, 1996).

Rebalancing trade-offs in a random-walk environment

Although the equity markets may seem to experience periods of trending and mean-reversion, a more realistic model of security-price movements is a random walk.[4] (The evidence against the random-walk model is often weak and time-period dependent [Campbell, Lo, and MacKinlay, 1996]). We conducted a simulation that assumes monthly security prices follow a random-walk pattern. We analyzed the impact of rebalancing strategies on both *relative* and *absolute* performance.

Table 2 shows the expected return and risk characteristics of portfolio-rebalancing strategies with reasonable ad hoc monitoring frequencies and rebalancing thresholds. The portfolios were rebalanced to the target asset allocation. We display the results for monthly, quarterly, and annual monitoring frequencies with 1%, 5%, and 10% rebalancing thresholds. If a portfolio is monitored monthly with a 1% threshold, in other words, it will be rebalanced if its actual asset allocation differs from its target asset allocation by 1% or more.

We compared the risk and return characteristics produced by these various rebalancing strategies relative to a target asset allocation of 60% equities and 40% bonds. The target allocation was rebalanced monthly irrespective of the magnitude of the allocation drift. The relative risk and return characteristics for the different rebalancing strategies are presented in the bottom three rows of Table 2. A portfolio that was rebalanced more frequently, either because it was monitored more frequently or because it had tighter rebalancing thresholds, tracked the target asset allocation more closely.

For example, a portfolio that was monitored monthly and rebalanced at 1% thresholds produced virtually no excess return or risk relative to the target allocation. Its worst relative 12-month loss was –0.206%. A portfolio that was monitored annually, with a rebalancing threshold of 10%, produced greater excess return and risk. Its worst relative 12-month loss was –2.227%.

Although this simulation implies that a more frequently rebalanced portfolio will have less risk than a less frequently rebalanced portfolio, it also suggests that the cost of rebalancing may place upper limits on the optimal number of rebalancing events. Transaction costs, taxes, and time and labor costs detract from the portfolio's return, potentially undermining the risk-control benefits of some rebalancing strategies. In our simulation, the number of rebalancing events and the annual turnover were proxies for costs. The actual costs will depend on a portfolio's unique transaction costs, taxes, and time and labor costs.

A rebalancing strategy that included monthly monitoring and 1% thresholds was more costly to implement (an average of 177.184 rebalancing events, with annual portfolio turnover of 7.126%) than one that included annual monitoring and 10% thresholds (an average of 3.520 rebalancing events and annual portfolio turnover of 1.051%).

4 More accurately, random walk with drift.

Table 2. A Range of Portfolio Rebalancing Strategies in a Random-Walk Return Environment

Monitoring frequency	Annually	Annually	Annually	Quarterly	Quarterly	Quarterly	Monthly	Monthly	Monthly
Threshold	10%	5%	1%	10%	5%	1%	10%	5%	1%
Average equity allocation	61.524%	60.549%	60.240%	61.279%	61.351%	59.996%	61.184%	60.276%	59.952%
Costs of rebalancing									
Annual turnover	1.051%	1.714%	2.722%	1.193%	2.085%	4.971%	1.242%	2.273%	7.126%
Number of rebalancing events	3.520	9.739	30.593	4.357	13.861	92.789	4.714	16.276	177.184
Absolute framework									
Average return	9.642%	9.615%	9.605%	9.637%	9.606%	9.594%	9.633%	9.604%	9.592%
Volatility	10.334%	10.201%	10.159%	10.298%	10.173%	10.123%	10.287%	10.161%	10.111%
Worst 12-month return	–16.643%	–16.338%	–16.267%	–16.529%	–16.367%	–16.475%	–16.540%	–16.403%	–16.555%
Relative framework									
Average excess return	0.051%	0.024%	0.013%	0.046%	0.015%	–0.003%	0.041%	0.012%	0.001%
Volatility of excess return	0.782%	0.502%	0.366%	0.366%	0.380%	0.162%	0.655%	0.336%	0.065%
Worst 12-month excess return	–2.227%	–1.331%	–0.959%	–1.955%	–0.956%	–0.454%	–1.835%	–0.834%	–0.206%

Notes: Average return, volatility, and correlation are based on historical returns from 1960 to 2003. Stocks are represented by the S & P 500 Index Monthly Dividend Reinvest (1960–1970) and by the Dow Jones Wilshire 5000 Index (1971–2003). Bonds are represented by the Lehman Corporate Bond Index (1960–1972), Lehman Government/Credit Index (1973–1975), and Lehman Aggregate Bond Index (1976–2003). There were no new contributions or withdrawals. Dividend payments were reinvested in equities; interest payments were reinvested in bonds. There were no taxes. All simulations used the same monthly average returns, correlations, and volatilities. The annual statistics were different, based on the imposed serial-correlation behavior. All statistics were annualized.

The performance data shown represent past performance, which is not a guarantee of future results. Investment returns will fluctuate. This hypothetical illustration does not represent the return on any particular investment.

Sources: Standard & Poor's, Dow Jones, and Lehman Brothers; author's calculations.

Costs also have an impact on rebalancing considerations outside the scope of our simulation—whether to rebalance to the target asset allocation or to some intermediate allocation. The decision depends on the *type* of rebalancing cost. When trading costs are mainly fixed and independent of the size of the trade—the cost of time, for example—rebalancing to the target allocation is optimal because it reduces the need for further transactions. On the other hand, when trading costs are mainly proportional to the size of the trade—as for commissions or taxes, for example—rebalancing to the closest rebalancing boundary is optimal, minimizing the size of the transaction. If both types of costs exist, the optimal strategy is to rebalance to some intermediate point. (See "The impact of rebalancing costs on rebalancing strategy" on page 10.)

The impact of rebalancing costs on rebalancing strategy

In the previous sections, we addressed any potential rebalancing costs implicitly by reporting the number of rebalancing events and the turnover ratio. In this section, we will discuss the implications of rebalancing costs on the rebalancing strategy.

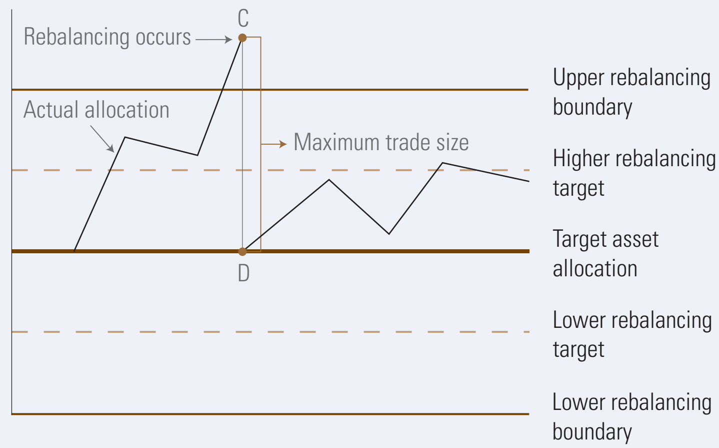
Fixed costs (such as time and labor costs)
When trading costs are mainly fixed, independent of the size of the trade, rebalancing to the target asset allocation is optimal to avoid the need for further transactions (Zakamouline, 2002). For nontaxable mutual fund investors, the primary rebalancing cost is the fixed cost.

Proportional costs (such as redemption fees and taxes)
On the other hand, when trading costs are mainly proportional to the size of the trade, rebalancing to the closest rebalancing boundary, which minimizes the size of the transaction, is optimal (Zakamouline, 2002).

If trading costs are lower for larger trade sizes, then portfolios may be better off rebalancing closer to the target asset allocation.

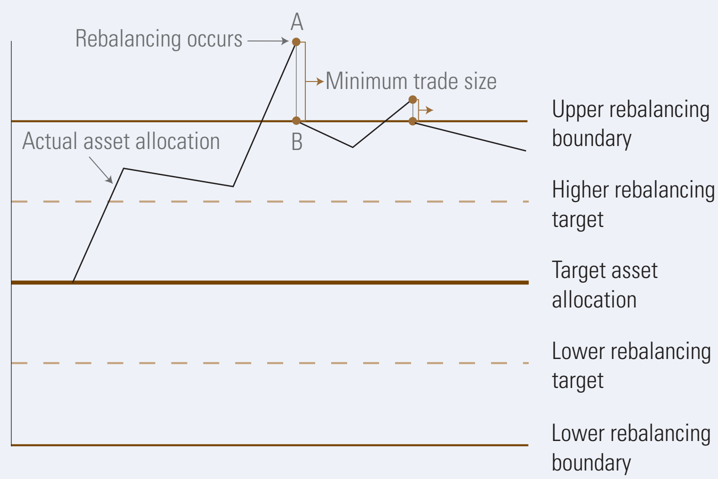
When both fixed and variable transaction costs exist, the investor should rebalance to an intermediate point between the target asset allocation and the rebalancing boundary (Zakamouline, 2002; Pliska and Suzuki, 2004). Most investors with taxable accounts incur both fixed and variable trading costs. However, the tax impact can be significantly reduced through customized strategies. In addition, the redemption fees may not be relevant for most investors.

Figure 2. Optimal Rebalancing Rule With Fixed Costs



Source: Vanguard Investment Counseling & Research.

Figure 3. Optimal Rebalancing Rule With Proportional Costs



Source: Vanguard Investment Counseling & Research.

Table 3. Historical Performance of Alternative Rebalancing Rules for a 60% Equity/40% Bond Portfolio (1960–2003)

Monitoring frequency	Monthly	Monthly	Quarterly	Annually	Never	Income
Threshold	0%	5%	5%	5%	None	None
Average equity allocation	60.055%	61.099%	61.014%	61.088%	74.366%	61.580%
Costs of rebalancing						
Annual turnover	9.130%	2.130%	2.670%	2.110%	0%	0%
Number of rebalancing events	528	17	18	13	0	0
Absolute framework						
Average return	9.509%	9.495%	9.669%	9.612%	9.655%	9.294%
Volatility	10.103%	10.182%	10.100%	10.165%	12.083%	10.126%
Worst 12-month return	–28.592%	–28.193%	–26.990%	–26.967%	–31.096%	–25.978%
Relative framework						
Average excess return		–0.013%	0.160%	0.103%	0.146%	–0.215%
Volatility of excess return		0.371%	0.431%	0.763%	2.650%	1.067%
Worst 12-month excess return		–1.331%	–0.959%	–1.955%	–0.956%	–0.454%

Notes: Stocks are represented by the S&P 500 Index Monthly Dividend Reinvest (1960–1970) and Dow Jones Wilshire 5000 Index (1971–2003). Bonds are represented by the Lehman Corporate Bond Index (1960–1972), Lehman Government/Credit Index (1973–1975), and Lehman Aggregate Bond Index (1976–2003). There were no new contributions or withdrawals. There were no taxes. Except in the "Income" column, dividend payments were reinvested in equities and interest payments were reinvested in bonds.

The performance data shown represent past performance, which is not a guarantee of future results. Investment returns will fluctuate. This hypothetical illustration does not represent the return on any particular investment.

Sources: Standard & Poor's, Dow Jones, and Lehman Brothers; author's calculations.

Implementing a rebalancing strategy

In translating this conceptual rebalancing framework into practical strategies, it's important to recognize two real-world limitations to the framework's assumptions. First, conventional wisdom among financial practitioners suggests that investor preferences may be less precise than assumed by theory. Institutional investors' target asset allocations are typically flexible within 5% to 10% ranges, indicating that managers are mostly indifferent to small risk or return deviations. Even if there are no rebalancing costs, the typical institution may opt for wider rebalancing thresholds and less frequent portfolio monitoring. Second, some costs of rebalancing—time, labor, and market impact—are difficult to quantify. Such costs are often included indirectly in advisory fees or reflected as trading restrictions, making it difficult to explicitly consider rebalancing costs.

Practical strategies aim to capture the risk-control benefits illustrated by our theoretical framework while minimizing the cost of rebalancing. Rebalancing a portfolio with dividends, interest payments, realized capital gains, or new contributions can help investors accomplish both goals. Tax-management strategies can also be used to minimize any tax impact.

Table 3 illustrates how dividend and interest payments can be used to reduce potential rebalancing costs. The last column of the table shows a 60% stock/40% bond portfolio that was rebalanced by investing the portfolio's dividend and interest payments in the underweighted asset class from 1960 to 2003. A manager who had simply redirected the portfolio's income would have achieved most of the risk-control benefits of more labor- and transaction-intensive rebalancing strategies at a much lower cost.

For example, a portfolio that was monitored monthly and rebalanced at 5% thresholds had 17 rebalancing events and annual portfolio turnover of 2.130%. The portfolio that was rebalanced with redirected income had no rebalancing events and portfolio turnover of 0%. For taxable investors, this strategy was also very tax-efficient. The differences in risk among the various rebalancing strategies were very modest. One caution: The high levels of dividends and interest rates during this 43-year period may not be available in the future. An effective approach that doesn't depend on the level of dividends and bond yields is to use portfolio contributions and withdrawals to rebalance the portfolio. However, the potential tax consequences of these transactions may require more customized rebalancing strategies.

Table 3 also illustrates the interplay of the various factors described in our conceptual rebalancing framework in a broadly diversified balanced portfolio during the past 40-plus years. We present the results for portfolios that were monitored monthly, quarterly, or annually and rebalanced if the allocation deviated more than 5% from the target asset allocation. We also show the alternative of no rebalancing. Results from the historical analysis are generally consistent with the random-walk simulation results in Table 2.[5,6]

The relatively small differences in risk and return among the various rebalancing strategies suggests that the rebalancing strategies based on various reasonable monitoring frequencies (every year or so) and reasonable allocation thresholds (variations of 5% or so) may provide sufficient risk control relative to the target asset allocations for most portfolios with broadly diversified stock and bond holdings.

There are two important qualifications to this conclusion. First, this analysis assumes that some approximation of the stock and bond markets' historical return patterns, average returns, volatility, and low return correlation can be expected to persist in the future. Second, our analysis assumes that a portfolio holds a broadly diversified set of liquid assets with readily available market prices.[7] These characteristics don't apply to some vehicles, such as hedge funds or private equity investments. Managers of these investment vehicles often require a lock-up period or provide limited liquidity, limiting an investor's ability to rebalance by selling an asset that has grown too large or by buying an asset that has fallen below its target weighting. Also, these investments, as well as alternatives such as directly held real estate, may report returns based on appraisal, rather than market pricing, which adds an element of subjectivity to the measure of an asset's weight in a portfolio. In such cases, our quantitative analysis may serve as a guide to qualitative judgment.

5 One anomaly—in this case, a positive anomaly—is the quarterly rebalancing strategy, which had a higher level of annualized excess return than strategies that rebalanced portfolios more or less frequently, or not at all. Oddly enough, the quarterly strategy also had a lower standard deviation and smaller maximum 12-month loss than portfolios that were rebalanced more frequently and a smaller maximum loss than a portfolio that was rebalanced more frequently. The anomalous results are the exception, rather than an actionable insight, that supports our general conclusions about rebalancing and risk control.

6 The absolute-return framework shows that more frequent rebalancing produced lower returns and lower volatility, but a higher maximum 12-month loss. This seemingly inconsistent result represents an instance of rebalancing in a downward-trending market, from September 1973 to September 1974. As noted earlier, rebalancing in a downward-trending market implies continually buying more of the asset that is performing worst. In judging the two risk measures presented in Table 2, it's worth remembering that the worst 12-month loss during the past 43 years represented just one moment in time. The annualized standard deviation of return summarizes portfolio volatility during the entire historical time period.

7 A concentrated or an aggressive, actively managed portfolio of stocks and bonds may also behave differently from our illustrated examples. Such portfolios tend to be more volatile than broadly diversified stock and bond portfolios (Tokat, 2005), requiring more frequent rebalancing to maintain similar risk control relative to the target asset allocation.

Conclusion

To ensure that a portfolio's risk and return characteristics remain consistent over time, a portfolio must be rebalanced. The appropriate rebalancing strategy depends on a number of factors such as the market environment and asset-class characteristics. Rebalancing achieves the goal of risk control relative to the target asset allocation in all market environments. Although market return patterns may create opportunities for tactical rebalancing, this active strategy is challenging.

Based on reasonable expectations about return patterns, average returns, risk, and correlations, we conclude that for most broadly diversified stock and bond fund portfolios, annual or semiannual monitoring, with rebalancing at 5% thresholds, produces an acceptable balance between risk control and cost minimization. To the extent possible, this rebalancing strategy should be carried out by appropriately redirecting interest income, dividends, new contributions, and withdrawals.

References

Campbell, John Y., Andrew W. Lo, and A. Craig MacKinlay, 1996. *The Econometrics of Financial Markets.* Princeton, N.J.: Princeton University Press. 632 p.

Leland, Hayne E., 1999. *Optimal Portfolio Management With Transactions Costs and Capital Gains Taxes.* Berkeley, Ca.: Institute of Business and Economic Research, University of California. 49 p. Research Program in Finance Working Paper No. 290.

Liu, Hong, and Mark Loewenstein, 2002. Optimal Portfolio Selection With Transaction Costs and Finite Horizons. *Review of Financial Studies* 15:805-35.

Pliska, Stanley R., and Kiyoshi Suzuki, 2004. *Optimal Tracking for Asset Allocation With Fixed and Proportional Transaction Costs. Quantitative Finance* 4(2):233-43.

Tokat, Yesim, 2005. *The Asset Allocation Debate: Provocative Questions, Enduring Realities.* Valley Forge, Pa.: Investment Counseling & Research, The Vanguard Group. 12 p.

Zakamouline, Valeri I., 2002. *Optimal Portfolio Selection With Transaction Costs for a CARA Investor With Finite Horizon.* Bergen, Norway: Institute of Finance and Management Science, Norwegian School of Economics and Business Administration. 36 p.

Vanguard Investment
Counseling & Research

P.O. Box 2600
Valley Forge, PA 19482-2600

Connect with Vanguard™ > www.vanguard.com > 800-523-1036

Vanguard Investment Counseling & Research

Catherine D. Gordon/Principal/Department Head

Joseph H. Davis, Ph.D./Principal
Francis M. Kinniry Jr., CFA/Principal
Daniel W. Wallick/Principal
Nelson W. Wicas, Ph.D./Principal

Frank J. Ambrosio, CFA
John Ameriks, Ph.D.
Donald G. Bennyhoff
Scott J. Donaldson, CFA, CFP®
Colleen M. Jaconetti, CFP, CPA
Kushal Kshirsagar, Ph.D.
Christopher B. Philips
Glenn Sheay, CFA
Kimberly A. Stockton
Yesim Tokat, Ph.D.
David J. Walker, CFA

For more information about Vanguard funds, visit www.vanguard.com, or call 800-662-7447, to obtain a prospectus. Investment objectives, risks, charges, expenses, and other important information about a fund are contained in the prospectus; read and consider it carefully before investing.

Vanguard Marketing Corporation, Distributor.

ICRPRTP 012006