Analysis of Fixed and Biased Asset Allocation Rebalancing Strategies

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Abstract

Over the years a number of tactical, dynamic and strategic approaches for asset allocation have been developed to improve the objectivity of portfolio management. One of the most popular approaches is to annually rebalance a portfolio of six to ten assets classes back to an equal or fixed percentage. Most researchers agree that this is essentially a contrarian strategy. This paper develops and evaluates an asset allocation methodology using a biasing factor that can implement a momentum strategy for investors who might prefer momentum investing. Three portfolio strategies, buy and hold, equal rebalancing and bias factor rebalancing are compared using 20 years of performance data and a diversified set of eight asset classes. The biased approach is then tested using two years of data not included in the original analysis data. The results indicate that the momentum approach can improve portfolio returns with reduced volatility.

I. Introduction

Over the last fifteen years the financial markets have witnessed the dot.com boom and bust, low inflation, a real estate bubble bursting, the near collapse of the banking system, a bond market rally with short term interest rates near zero and gold reaching all-time highs. The gyrations of the financial markets over the last decade have led even the most knowledgeable investors to question many long held beliefs. Is "buy and hold" dead? Are the contrarians correct to continue buying out of favor assets? Is there a "herd mentality" that results in unjustified asset valuations? Whatever happened to the old adage to "trim your losses and let your winners run?"

Asset allocation strategies were developed to help investors diversify their portfolio, reduce overall risk and improve investor objectivity. One of the most popular variations is to invest 60% in stock and 40% in bonds and rebalance the portfolio back to the 60/40 split at the end of the year. An equally popular approach is to set a static or equal percentage in a wide range of asset classes including large cap, mid cap, small cap, international, US bonds, global bonds and commodities based on an acceptable risk tolerance for a given investor. This approach typically rebalances the portfolio to the target percentage levels every twelve months. We will refer to this strategy as the equal rebalancing strategy and it will be compared to the biased strategy presented.

Following such an asset allocation policy, "that goes against prevailing market trends by buying assets that are performing poorly and then selling when they perform well … is undoubtedly contrarian … to repeat the obvious, rebalancing a portfolio to a previously set asset allocation policy involves selling relative winners and buying relative losers" (Sharpe 2010). Given the popularity of the fixed rebalancing strategy, would it be possible to "let the winners run" using a momentum asset allocation strategy? Would the results be better or worse than the equal allocation strategy? These questions motivated the following analyses.

Arnott (2006) states that a, "disciplined management of the asset mix can be as simple as rebalancing or as aggressive as a large allocation to tactical asset allocation, seeking to sell overvalued and buy undervalued asset classes … with disciplined risk management and on a scale large enough to matter, we may identify investments that are more attractively priced than mainstream stocks or bonds and that can reduce our portfolio risk. Commodities, for instance are a high-risk asset class when viewed in isolation, but the negligible correlation with a 60/40 equity/bond portfolio presents a powerful opportunity for diversification and portfolio risk reduction."

Swales, Chang and Bowdidge (2007) investigated life cycle funds that alter the allocation of financial assets based on a person's life cycle with riskier classes while the person is younger and less risky as the per gets older. Their research found, "on average, expense and turnover ratios, return and star ratings and performance are higher for life-cycle funds than their all mutual funds counterparts. Additionally, life-cycle funds generally have lower standard deviations, but slightly higher betas than the mutual fund composite. Life-cycle funds, on average, had higher risk-adjusted alpha returns."

Bogle (2014), the father of low cost index funds, has become an outspoken critic of financial "system insiders." He thinks investors will "choose low-cost, low-turnover, middle-of-the-road strategies, buying and holding their investment portfolios for the long term." He also thinks investors will see the benefits of index funds and become more cautious of actively traded mutual funds and their manager. A recent article in the Wall Street Journal (Zweig 2014) states that, "stock indexing racks up another triumphant year with only 9.3% of mutual funds investing in big US stocks beat the index through September 2014."

Holzhauer, Lu, McLeod, and Mehran (2013) caution that all index funds have a primary disadvantage of tracking error. In other words, they are not able to perfectly replicate the performance of the underlying index. "Although similar to other index funds, ETFs are

especially affected by corporate behavior like dividend decisions, which can quickly change the asset allocation of an index."

Davis (2010) reports on a study produced by Vanguard regarding portfolio rebalancing. He states that, "The whole point of rebalancing is to reduce the risk of a portfolio, not to maximize its returns … Rebalancing is one of the aspects of portfolio management that has strong theoretical justification, but is not as easy to implement as it should be." The article also states that there has, "only been seven occasions since 1926 when the manager of a portfolio with a 5 per cent trigger for rebalancing would have needed to take decisive corrective action to go back into the equity market following a market fall." This result tends to reinforce the "buy and hold" comment of Bogle (2014). One of the more interesting results of the Vanguard study was that, "The annualized returns and volatility of a 60/40 portfolio turn out to have been similar historically whether it is rebalanced monthly, quarterly or annually."

The results presented in this paper begin with the passive buy and hold strategy and a typical active asset allocation with equal percentage annual rebalancing to see how investors have fared over the last two decades with these two approaches. The paper then proposes and analyzes rebalancing with a biasing factor methodology that can implement both a contrarian and momentum approach at varying levels. A comparison of these three basic approaches leads to the conclusion that a momentum biasing factor approach can provide higher portfolio returns with less risk than either the buy and hold or a traditional equal weight rebalancing strategies.

In order to minimize the weaknesses of backtesting, all analyses were performed with data from 1992 to 2011. The data from 2012 and 2013 were then used to test the biased allocation strategies to see if they performed as well as in the 1992-2011 period. The final section of the paper details the results with the additional two years added to the data set.

II. Asset Classes

There are many ways to segment and define asset classes. Even the basic "US stocks" asset class can be sliced and diced many ways into large cap, midcap, small cap, microcap, value, growth, and industry segments. A common depiction of asset class returns is a periodic chart of investment returns as shown in MFS (2014). The chart graphically depicts each year's strongest and weakest performers in descending order to encourage investors to diversify their portfolios. The asset classes in the MFS periodic chart are the beginning point of our research and are defined as:

Commodities:	Dow Jones – UBS Commodity Index
Bonds:	Barclays U.S. Aggregate Bond Index
Global Bonds:	JPMorgan Global Government Bond Index (unhedged)
International Stocks:	MSCI EAFE Index
Large Cap Growth Stocks:	Russell 1000 Growth Index
Large Cap Value Stocks:	Russell 1000 Value Index
Real Estates Securities:	FTSE NAREIT All REITs Total Return Index
Small/Mid Cap Stocks:	Russell 2500 Index

Year ending returns for each asset class are listed in Table I with summary statistics for the 20 year period. These assets classes and the investing strategies presented and can be implemented using index mutual funds or ETFs.

Table I

Year End Annual Rate of Return by Asset Class

Year	Intl Stocks	Large-cap Growth	Large-cap Value	Small & Mid-cap	Bonds	Global Bonds	REITs	Commod-ities
1992	-11.85%	4.99%	13.58%	16.09%	7.40%	4.55%	12.17%	3.70%
1993	32.94%	2.87%	18.07%	16.55%	9.75%	12.27%	18.55%	-1.07%
1994	8.06%	2.62%	-1.98%	-1.05%	-2.92%	1.28%	0.81%	16.61%
1995	11.55%	37.18%	38.36%	31.70%	18.47%	19.32%	18.31%	15.21%
1996	6.36%	23.12%	21.64%	19.03%	3.63%	4.40%	35.75%	23.16%
1997	2.06%	30.49%	35.18%	24.36%	9.65%	1.40%	18.86%	-3.39%
1998	20.33%	38.71%	15.63%	0.38%	8.69%	15.31%	-18.82%	-27.03%
1999	27.30%	33.16%	7.35%	24.14%	-0.82%	-5.08%	-6.48%	24.35%
2000	-13.96%	-22.42%	7.01%	4.27%	11.63%	2.34%	25.89%	31.84%
2001	-21.21%	-20.42%	-5.59%	1.22%	8.44%	-0.79%	15.50%	-19.51%
2002	-15.66%	-27.88%	-15.52%	-17.80%	10.25%	19.37%	5.22%	25.91%
2003	39.17%	29.75%	30.03%	45.51%	4.10%	14.51%	38.47%	23.93%
2004	20.70%	6.30%	16.49%	18.29%	4.34%	10.10%	30.41%	9.15%
2005	14.02%	5.26%	7.05%	8.11%	2.43%	-6.53%	8.29%	21.36%
2006	26.86%	9.07%	22.25%	16.17%	4.33%	5.94%	34.35%	2.07%
2007	11.63%	11.81%	-0.17%	1.38%	6.97%	10.81%	-17.83%	16.23%
2008	-43.06%	-38.44%	-36.85%	-36.79%	5.24%	12.00%	-37.34%	-35.65%
2009	32.46%	37.21%	19.69%	34.39%	5.93%	1.90%	27.45%	18.91%
2010	8.21%	16.71%	15.51%	26.71%	6.54%	6.42%	27.58%	16.83%
2011	-11.73%	2.64%	0.39%	-2.51%	7.84%	7.22%	7.28%	-13.32%
Geometric Returns	4.9%	6.6%	8.9%	9.8%	6.5%	6.6%	10.2%	5.6%
Aritmetic Mean	7.2%	9.1%	10.4%	11.5%	6.6%	6.8%	12.2%	7.5%
Standard Deviation	21.3%	22.8%	17.5%	18.9%	4.6%	7.3%	20.2%	18.9%

III. Buy and Hold Strategy

A buy and hold strategy is considered passive since no rebalancing is performed. Table II depicts a hypothetical portfolio of $80,000 equally distributed across the eight asset classes with $10,000 invested in each asset class at the beginning of the year 1992. The amount in each asset class is maintained from year to year with no rebalancing. For example, the $10,000 invested in Real Estate (REITs) at the beginning of the year 1992 grows to $11,217 by the end of the year. That balance remains invested in the real estate asset class and grows to $13,298 by the end of the second year. At the end of the 20th year (2011), the original $10,000 has grown to $70,136.

Table II								
Buy and Hold with No Rebalancing								
	1992	1993	----------	2010	2011			
International stocks	$8,815	$11,719		$29,728	$26,241			
Large-cap growth	$10,499	$10,800		$35,062	$35,988			
Large-cap value	$11,358	$13,410		$54,740	$54,953			
Small/Mid-cap	$11,609	$13,530		$66,561	$64,890			
Bonds	$10,740	$11,787		$32,683	$35,245			
Global bonds	$10,455	$11,738		$33,469	$35,885			
REITs	$11,217	$13,298		$65,377	$70,136	Geometric	Arithmetic	Standard
Commodities	$10,370	$10,259		$34,616	$30,005	Return	Mean	Deviation
Year End Value	$85,063	$96,541		$352,235	$353,344			
Year End ROI	6.33%	13.49%		17.24%	0.31%	7.71%	8.60%	13.38%

IV. Equal Percentage Rebalancing Strategy

Periodically rebalancing a portfolio is considered an active approach to investing. In a typical 60/40 asset allocation strategy, the portfolio is rebalanced at the end of the holding period such that the amount invested in stocks is 60% of the total portfolio at the beginning of the following period. The remaining 40% is then invested in bonds. While a 60/40 asset split is not an equal percentage, it is a very simple and common allocation strategy. When more than a few asset classes are employed, a basic approach is to place an equal percentage in each asset class. Given eight asset classes, 12.5% of the portfolio is allocated to each asset class as defined in the equations below.

The equal percentage approach as well as the biased approaches, all begin with *n (i = 1..n)* asset classes and the dollar amount invested at the beginning of each year represented by X_i. The amount initially invested at $t = 0$ in the n assets classes are $X_1=X_2 \ldots =X_n$. The initial value of the portfolio (V) is then:

$$V_{t=0} = \sum_{i=1,n} X_{i,t=0} \qquad (1)$$

For the equal percentage rebalancing approach, an equal percentage ($p_i = 1/n$), which is fixed over time, is applied to each asset class for each time period ($t = 0 \ldots x$) such that:

$$V_{t+1} = \sum_{i=1,n} p_i V_t \qquad (2)$$

Equation 2 is applied for each year using the data in Table I. The results for the equal rebalancing approach are shown in Table III.

Table III								
Equal Rebalancing at End of Each Year								
	1992	1993	----------	2010	2011			
International stocks	$8,815	$14,135		$45,593	$42,980			
Large-cap growth	$10,499	$10,938		$49,174	$49,976			
Large-cap value	$11,358	$12,554		$48,668	$48,881			
Small/Mid-cap	$11,609	$12,393		$53,387	$47,469			
Bonds	$10,740	$11,670		$44,889	$52,508			
Global bonds	$10,455	$11,938		$44,838	$52,206			
REITs	$11,217	$12,605		$53,754	$52,236	Geometric	Arithmetic	Standard
Commodities	$10,370	$10,519		$49,225	$42,205	Return	Mean	Deviation
Year End Value	$85,063	$96,752		$389,528	$388,462			
Year End ROI	6.33%	13.74%		15.56%	-0.27%	8.22%	8.92%	12.03%
Next Year Beg Amt	$10,633	$12,094		$48,691	$48,558			

V. Biased Rebalancing Strategy

Sharpe regards the equal rebalancing to be a contrarian approach. For the "biased" approach presented in this paper, it is actually a mildly contrarian strategy. The biased approach is able to implement a much stronger contrarian strategy or a momentum strategy. The focus of the rest of this paper is to determine if applying a momentum or stronger contrarian bias into the rebalancing strategy can improve the overall performance of the equal rebalancing strategy.

To answer this question, a biasing factor is added to Equation 2. Two biasing approaches were examined. Equation 3 implements the biased, proportionally weighted approach which gives more weight to the best or worst performing asset class depending on whether a momentum or contrarian bias is desired. Equation 4 produces a biased, non-proportional approach.

For both biased approaches the contrarian bias is implemented with a negative biasing factor (b) which is applied to each X_i for each year based on its prior year performance. The investor then sells more of the best and better performing asset class in rank order (r = 1 to n/2) at the end of the year. When the middle of the rank is reached, the investor progressively buys more of the poorer performing assets classes placing the largest amount in the poorest performer. To implement a momentum bias, b takes on positive values buying more of the better performing asset classes. After considerable analysis it was determined that the overall performance difference, as compared to equal rebalancing, was minimal.

$$X_{i,t} = p_i \, V_{i,t-1} + p_i \, V_{i,t-1} * (.5 * (n+1) - r_{i,t-1}) * b \qquad (3)$$

The non-proportional approach replaces .5*(n+1) in Equation 3 with n (assuming n is even) resulting in Equation 4. For the full momentum strategy, the biasing factor is set to +100%.

$$X_{i,t} = p_i \, V_{i,t-1} + p_i \, V_{i,t-1} * (n - r_{i,t-1}) * b \qquad (4)$$

The total value of the portfolio at the beginning of the year is then equally distributed to the top performing n/2 asset classes from the prior year and nothing to the bottom n/2 performing asset classes. To apply a full contrarian strategy, the biasing factor is set to -100%. The total amount of the portfolio at the beginning of the year is equally distributed to the poorest performing n/2 asset classes from the prior year and nothing to the strongest n/2 performing asset classes.

Any value between ±1% and ±100% can be selected, but b = -100%, 0%, and 100% shows the full range of possible returns. When b = 0, the last term drops out implementing an equal rebalancing strategy, specifically Equation 2. The results for the full contrarian approach are shown in Table IV and the results for the full momentum approach are shown in Table V.

Table IV

Year End Results for Full Contrarian Bias Strategy (b = -100% and rebalanced each year)

	1992	1993	----------	2010	2011			
International stocks	$8,815	$28,271		$0	$75,690			
Large-cap growth	$10,499	$21,876		$0	$0			
Large-cap value	$11,358	$0		$88,972	$86,083			
Small/Mid-cap	$11,609	$0		$0	$0			
Bonds	$10,740	$0		$82,063	$92,471			
Global bonds	$10,455	$23,875		$81,971	$91,940			
REITs	$11,217	$0		$0	$0			
Commodities	$10,370	$21,038		$89,989	$0	Geometric	Arithmetic	Standard
Year End Value	$85,063	$95,060		$342,995	$346,185	Return	Mean	Deviation
Year End ROI	6.33%	11.75%		11.33%	0.93%	7.60%	8.48%	13.78%

Table V

Year End Results for Full Momentum Bias Strategy (b = +100% and rebalanced each year)

	1992	1993	----------	2010	2011			
International stocks	$8,815	$0		$96,725	$0			
Large-cap growth	$10,499	$0		$104,323	$109,914			
Large-cap value	$11,358	$25,108		$0	$0			
Small/Mid-cap	$11,609	$24,785		$113,261	$104,399			
Bonds	$10,740	$23,339		$0	$0			
Global bonds	$10,455	$0		$0	$0			
REITs	$11,217	$25,211		$114,039	$114,883			
Commodities	$10,370	$0		$0	$92,823	Geometric	Arithmetic	Standard
Year End Value	$85,063	$98,443		$428,347	$422,018	Return	Mean	Deviation
Year End ROI	6.33%	15.73%		19.80%	-1.48%	8.67%	9.36%	11.90%

VI. Comparison of the Four Portfolio Strategies

The performances of the full momentum and full contrarian strategies for the 20 year period are shown in Table VI along with the buy and hold and fixed rebalancing strategies. The Sharpe ratios are calculated using the buy and hold arithmetic mean as the reference point. The three active strategies are considered the alternative investments. Specifically, the Sharpe ratio for 100% momentum is calculated as follows:

(100% Momentum Arithmetic Mean – Buy & Hold Arithmetic Mean) / (100% Momentum STD)

While following a 100% momentum strategy does not produce a well-diversified portfolio, it is intriguing that a rather simple variation of the traditional equal rebalancing approach can improve the risk adjusted portfolio return as measured by the Sharpe ratio.

Table VI
Comparison of All Four Portfolio Strategies

	1992-2011 (20 yrs)		
Portfolio Strategy	Arithmetic Mean ROI	Standard Deviation	Sharpe Ratio
Buy and Hold	8.60%	12.88%	0.00
100% Momentum	9.36%	11.90%	0.06
Equal Annual Rebalancing	8.92%	12.03%	0.03
100% Contrarian	8.48%	13.78%	-0.01

VI. Application of Strategy and Results Including the 2012 and 2013 Data

The above results are for the data up to and including 2011. Data for 2012 and 2013 are shown to in order to validate the approach as a predictive process and not a best fit model using backtesting. The annual returns for each asset class for these two additional years are shown in Table VII.

Table VII
2012 and 2013 Year End Annual Rate of Return by Asset Class

Year	Intl Stocks	Large-cap Growth	Large-cap Value	Small & Mid-cap	Bonds	Global Bonds	REITs	Commod-ities
2012	17.90%	15.26%	17.51%	17.88%	4.21%	1.30%	20.14%	-1.06%
2013	23.29%	33.48%	32.53%	36.80%	-2.02%	-4.50%	3.21%	-9.52%
22 Year Geometric Returns	6.27%	8.09%	10.25%	11.26%	5.99%	5.82%	10.33%	4.59%
22 Year Arithmetic Mean	8.43%	10.52%	11.73%	12.95%	6.09%	6.07%	12.17%	6.31%
22 Year Standard Deviation	20.64%	22.28%	17.39%	18.76%	4.75%	7.46%	19.38%	18.45%

The results of adding the data for the 2012 and 2013 to the original 20 year data set are shown in the 22 year section of Table VIII. To minimize the influence of the earlier years, the results for the three year period beginning January 2011 through December of 2013 are shown in the far right section of the Table VIII. For both the 3 year and 22 year periods the Sharpe ratio indicates the 100% momentum approach outperforms the other three strategies. Conversely, the 100%

contrarian approach has the poorest Sharpe ratio for both time periods. These results are consistent with the 20 year results shown in Table VI in which the 100% momentum is the best and the 100% contrarian is the poorest performer using the Sharpe ratios.

Table VIII

Comparison of All Four Portfolio Strategies

	1992-2013 (22 yrs)			2011-2013 (3 yrs)		
Portfolio Strategy	Arithmetic Mean ROI	Standard Deviation	Sharpe Ratio	Arithmetic Mean ROI	Standard Deviation	Sharpe Ratio
Buy and Hold	9.19%	12.88%	0.00	10.19%	8.74%	0.00
100% Momentum	10.07%	11.74%	0.07	10.90%	12.73%	0.06
Equal Annual Rebalancing	9.28%	11.51%	0.01	8.51%	7.71%	-0.22
100% Contrarian	8.50%	13.17%	-0.05	6.12%	6.25%	-0.65

VII. Conclusions

This research demonstrates that there is a wide range of active rebalancing approaches that can easily implement either a momentum or a stronger contrarian strategy. In addition, the findings present considerable evidence that a partial or full biased momentum approach can result in improved portfolio performance with reduced risk over longer time periods. Furthermore, the results for buy and hold show that the traditional equal rebalancing strategy may not be worth the extra effort required to implement it.

Surprisingly, even though the full momentum approaches are less diversified than the buy and hold or the equal rebalancing strategies, it resulted in superior risk adjusted returns as measured by the Sharpe ratio. In addition, if an investor finds it difficult to rebalance, as Davis (2010) reports, the small difference between the risk adjusted returns of the momentum strategy and the buy and hold approach may also favor the buy and hold approach.

The results of this study motivate two topics for future research. First, given the disadvantage of tracking error discussed bv Holzhauer, Lu, McLeod, and Mehran (2013), what are the results of the biased rebalancing strategy when implemented with actual index funds and ETFs? Secondly, the authors noticed that under particular market conditions, it might be possible to enhance returns by substituting the contrarian approach for the momentum approach when the market conditions occur. Considerable analysis would be necessary to confirm this observation.

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