Return Attribution: A Modified Bootstrapping Approach

John M. Geppert
University of Nebraska- Lincoln

Donna M. Dudney
University of Nebraska- Lincoln

The return to an investment strategy results from the combined effect of three types of decisions: (1) which assets to consider (selection), (2) the proportion of wealth to allocate to each asset (allocation) and (3) when to rebalance the portfolio (rebalancing). In this paper, we develop an easy to implement, bootstrapping procedure which can disentangle the total ex-post investment return into its component parts. Rebalancing results in transactions cost that partially offset returns. Our procedure allows one to assess ex-post whether the additional cost of rebalancing is justified by higher returns.

INTRODUCTION

The question of whether markets price assets in an efficient manner is of primary importance in financial theory and has considerable implications for practitioners. While the exact definition of an "efficient" market may differ depending on the context, Fama (1991) organizes tests for market efficiency into three categories: 1) tests for return predictability, 2) event studies, and 3) tests for market responses to private information. Many tests of strategies designed to exploit possible market inefficiencies are based upon the application of a trading rule whereby investors buy or sell based upon some signal (e.g., a technical trading rule or earnings surprises). Often, the metric of a strategy's success is simply whether it results in more accumulated wealth than some reference strategy. The reference strategy is typically the performance of some benchmark or likely investment alternative such as a risk-free asset or an unmanaged market index (see for example Andrade, Babenko and Tserlukevich, (2006)). Various return performance measures are reported, but often the emphasis is on total return with perhaps some risk adjustment. Alternately, profits from the trading strategy may be compared to profits from applying the same trading rule to data created using a bootstrapping procedure that simulates a random walk, AR(1), GARCH or similar return process (see for example Brock, Lakonisok and LeBaron, (1992); Osler and Chang, (1995); Marshall, Cahan, and Cahan, (2008); and Park and Irwin, (2008)). The bootstrap approach is an improvement over simple t-tests of differences in mean profits between a trading strategy and a strategy of buying and holding a benchmark asset. The t-test assumes normal, stationary and time independent distributions, whereas the bootstrap methodology allows modeling of a wide range of distributions that capture the leptokurtosis, autocorrelation, and conditional heteroskedasticity documented in stock market returns.

Return differences between the trading strategy and a bootstrapped or benchmark strategy may be due to either investing in assets that differ from the benchmark (selection), investing in the same assets as the benchmark but in different proportions (allocation) or shifting the composition of the assets in a manner different from the benchmark (rebalancing). Previous approaches do not allow decomposition of returns into these component parts. However, disentangling the impact on return of these three components provides insight into the economic value of the trading strategy. For example, if the majority of the strategy's returns were derived from allocation and selection, then the rebalancing activity simply resulted in excessive transactions costs.

This paper introduces a new procedure for measuring the performance of a wide range of investment strategies. Our bootstrap procedure allows ex-post returns from an investment strategy to be separated into rebalancing and allocation components. By holding constant the allocation decision, our approach ensures that benefits from allocation are not falsely attributed to rebalancing (timing) efforts[1]. Since many trading strategies (particularly technical trading rules), are essentially timing strategies, this separation is critical. Our approach is particularly useful in evaluating the performance of portfolio managers, and in determining whether efforts expended on portfolio rebalancing produce incremental returns in excess of the incremental costs. Our approach is described intuitively below, followed by an application of our technique to a trading rule based on Federal Reserve discount rate signals.

EXPLANATION OF OUR APPROACH

We consider the sources of return as selection, allocation and rebalancing. The allocation decision is simply the proportion of one's wealth in each of the portfolio's assets. For simplicity, we can subsume the selection decision into the allocation decision by defining the investment choice set as all conceivable assets and then assigning a portfolio weight of zero to those assets not selected. With this convention, any ex-post investment strategy can be decomposed into allocation and rebalancing decisions. This approach is illustrated in Figure 1.

FIGURE 1
DEFINING AN INVESTMENT STRATEGY

	Time Line	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Stock Index Monthly Return		0.25%	0.42%	0.58%	0.33%	-0.17%	0.08%	0.08%	-0.17%	-0.25%	-0.25%	0.33%	0.42%
Bond Index Monthly Return		0.08%	0.17%	0.08%	0.08%	0.08%	0.04%	0.08%	0.17%	0.08%	0.08%	0.08%	0.08%

INITIAL INVESTMENT STRATEGY

	Time Line	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Stock Index Proportion		0.8			0.75		0.8	0.75	0.85		0.6		
Bond Index Proportion		0.2			0.25		0.2	0.25	0.15		0.4		
		A1			A2		A3	A4	A5		A6		

END OF MONTH BALANCE

	Time Line	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Stock Account		$ 0.8020	$ 0.8053	$ 0.8100	$ 0.7606	$ 0.7593	$ 0.8106	$ 0.7605	$ 0.8605	$ 0.8583	$ 0.6050	$ 0.6070	$ 0.6095
Bond Account		$ 0.2002	$ 0.2005	$ 0.2007	$ 0.2529	$ 0.2531	$ 0.2026	$ 0.2535	$ 0.1524	$ 0.1525	$ 0.4047	$ 0.4050	$ 0.4053
Total Wealth		$ 1.0022	$ 1.0058	$ 1.0107	$ 1.0134	$ 1.0124	$ 1.0131	$ 1.0140	$ 1.0128	$ 1.0108	$ 1.0096	$ 1.0120	$ 1.0148

The top panel gives the ex-post monthly returns from the stock and bond indices used in the investment strategy. The middle panel gives the allocation and rebalancing decisions that constitute the initial investment strategy. There are six "allocation/buy-and-hold" blocks A1-A6 and five rebalancing decisions. The bottom panel indicates the wealth accumulation resulting from the allocation and rebalancing decisions.

Figure 1 shows an example investment strategy that spans twelve months and considers only stock and bond indices as possible assets. The top panel of Figure 1 shows the ex-post monthly returns from the stock and bond indices over the twelve month horizon considered. The middle panel shows the allocation and rebalancing decisions that constitute the initial investment strategy. The initial allocation decision is to apportion 80 percent of the investment into the stock index and 20 percent into the bond index (A1 in Figure 1). No further action is taken by the investor until the end of month three. Note that the portfolio weights in months two and three are likely to passively change as market values of the asset classes fluctuate. However, no active allocation changes are initiated by the investor during this period. This mimics a buy-and-hold strategy until the end of month three. Because it is common to think of buy-and-hold as "unmanaged," we define the first three months to be one allocation decision, since after the initial allocation no action is taken by the investor. We call each string of non-trading a "buy-and-hold" block. At the end of month three, there is a rebalancing decision that downplays the stock index and rebalances toward bonds (A2 in Figure 1). The second rebalancing decision allocates 75 percent to stocks and 25 percent to bonds. This starts the second buy-and-hold block which remains through month five at which time the third rebalancing decision is made. The allocation and rebalancing continues through month twelve. Using this convention, Figure 1 shows that there are six active allocation decisions (six buy-and-hold blocks labeled A1 through A6) and five rebalancing decisions (A2 through A6). The pattern of allocation and rebalancing in Figure 1 fully characterizes the ex-post decisions used in our example investment strategy and the resulting return path. The wealth accumulation over the twelve month period is shown in the third panel of Figure 1 and is illustrated graphically in Figure 2.

FIGURE 2
INITIAL INVESTMENT STRATEGY WEALTH ACCUMULATION

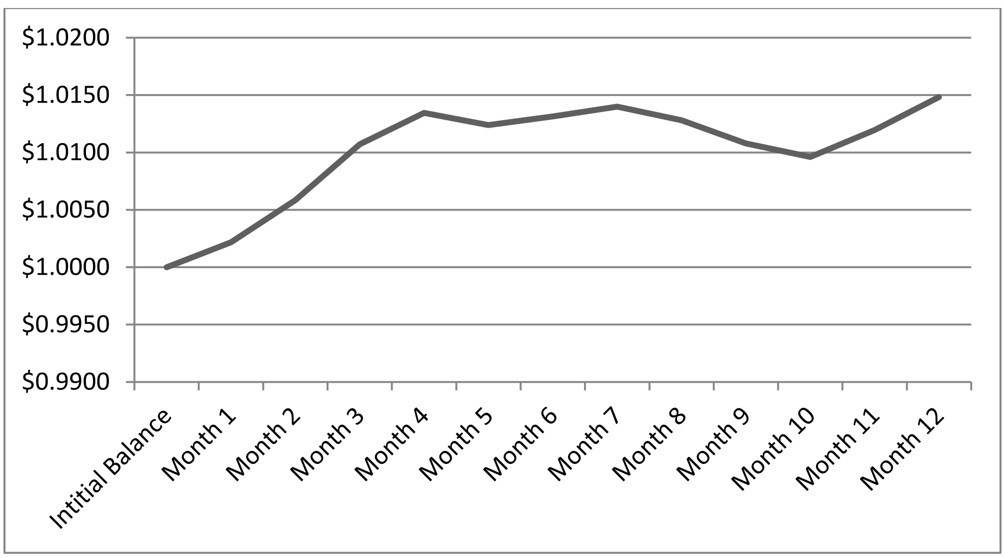


Figure 2 shows the wealth accumulation from a one dollar investment in the initial investment strategy shown in Figure 1.

The investment strategy shown in Figure 1 is just one of a large number of possible allocation and rebalancing strategies for a twelve month investment horizon with stock and bond indices. We want to compare it to other possible strategies that one might have taken over the same twelve month period. Each other alternative strategy would in general have resulted in a different cumulative twelve-month return. In addition, the source of each strategy's return (from allocation or from rebalancing), would also differ. For the investment strategy illustrated in Figure 1, our objective is to isolate the returns derived from allocation from those derived from rebalancing by holding constant the impact of allocation decisions. We accomplish this by randomly shuffling the buy-and-hold allocation blocks, a process we refer to as a bootstrap shuffle.

To understand the intuition behind our shuffle process, we need to highlight when rebalancing affects returns. Profitable rebalancing is predicated on variation in asset return distributions. To see this, consider a world where the distribution of asset returns is fixed for all time. Also assume that an investor alternates between two possible investment allocations, A1 and A2 over a two month horizon. With fixed return distributions, the statistical properties of the two investment alternatives shown below would be identical, in spite of the different time periods associated with each allocation:
$PDF[(1 + R_t^{A1})(1 + R_{t+1}^{A2})] = PDF[(1 + R_t^{A2})(1 + R_{t+1}^{A1})]$, where PDF is the probability density function of the associated accumulated wealth distributions.

On the left-hand side of the equation the investor first invests with allocation A1 in period t and then rebalances to allocation A2 in period t+1. On the right-hand side, the time periods for allocations A1 and A2 are reversed. The ordering of the allocations is irrelevant when the return distributions are fixed; only the amount of time in each allocation is relevant, not when the allocations are implemented. It is important to note that the ex-post results for the two alternatives will not in general be the same - only the expected values and other statistical properties of the two strategies will be identical. Figure 3 illustrates the concept with our twelve-period example from Figure 1.

FIGURE 3
SHUFFLING ILLUSTRATION

Initial Investment Strategy from Figure 1

	Time Line	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Stock Index Proportion		0.8			0.75		0.8	0.75	0.85		0.6		
Bond Index Proportion		0.2			0.25		0.2	0.25	0.15		0.4		
		A1			A2		A3	A4	A5		A6		

Initial Investment Strategy End of Month Balance

	Time Line	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Stock Account		$ 0.8020	$ 0.8053	$ 0.8100	$ 0.7606	$ 0.7593	$ 0.8106	$ 0.7605	$ 0.8605	$ 0.8583	$ 0.6050	$ 0.6070	$ 0.6095
Bond Account		$ 0.2002	$ 0.2005	$ 0.2007	$ 0.2529	$ 0.2531	$ 0.2026	$ 0.2535	$ 0.1524	$ 0.1525	$ 0.4047	$ 0.4050	$ 0.4053
Total Wealth		$ 1.0022	$ 1.0058	$ 1.0107	$ 1.0134	$ 1.0124	$ 1.0131	$ 1.0140	$ 1.0128	$ 1.0108	$ 1.0096	$ 1.0120	$ 1.0148

Alternative Strategy

	Time Line	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Stock Index Proportion		0.6			0.8			0.8	0.75		0.75	0.85	
Bond Index Proportion		0.4			0.2			0.2	0.25		0.25	0.15	
		A6			A1			A3	A2		A4	A5	

Alternative Strategy End of Month Balance

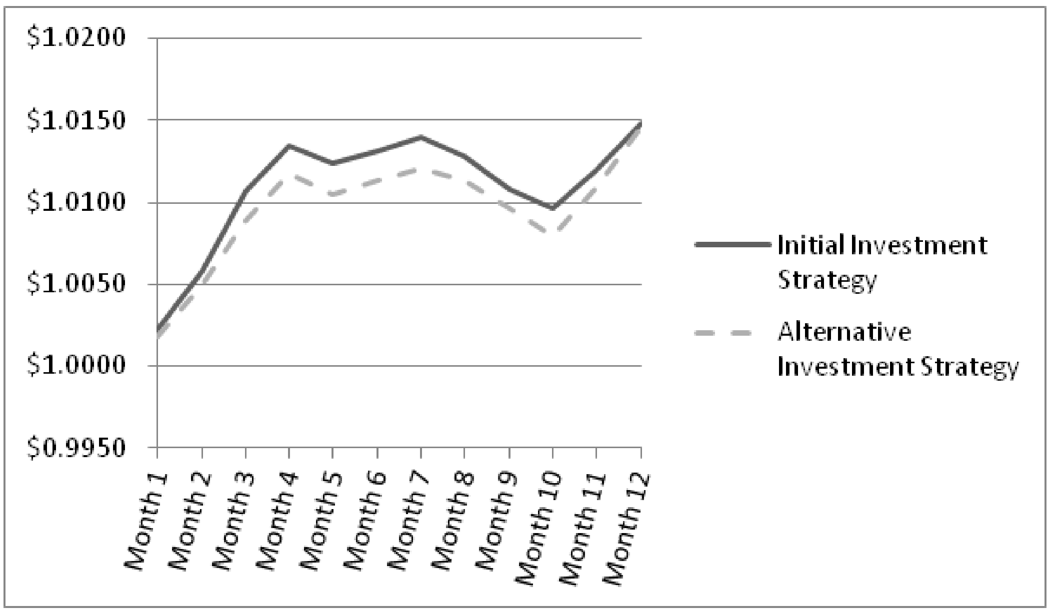
	Time Line	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Stock Account		$ 0.6015	$ 0.6040	$ 0.6075	$ 0.8098	$ 0.8084	$ 0.8091	$ 0.8097	$ 0.7578	$ 0.7559	$ 0.7541	$ 0.8596	$ 0.8632
Bond Account		$ 0.4003	$ 0.0401	$ 0.4013	$ 0.2019	$ 0.2021	$ 0.2022	$ 0.2024	$ 0.2535	$ 0.2537	$ 0.2539	$ 0.1513	$ 0.1514
Total Wealth		$ 1.0018	$ 1.0050	$ 1.0089	$ 1.0117	$ 1.0105	$ 1.0113	$ 1.0121	$ 1.0113	$ 1.0096	$ 1.0079	$ 1.0109	$ 1.0146

The initial investment strategy consists of six allocation buy-and-hold blocks. The first block, A1, has an initial allocation of 80 percent of wealth to the stock index and 20 percent in the bond index. This buy-and-hold position remains through month three. The corresponding allocation buy-and-hold block in the alternative investment strategy is in month eleven.

Because we are trying to separate the effects of rebalancing from allocation, the alternative investments we consider preserve the allocation proportions and buy-and-hold block lengths, but alter the timing of the rebalancing. We call these "allocation preserving strategies." For ease of comparison, the top two panels of Figure 3 repeat the pattern of allocation and rebalancing of the initial investment strategy shown in Figure 1. In the third panel, we show one possible allocation preserving strategy alternative where the allocation decisions remain unaltered, while the location of the rebalancing decisions is changed. For example, the allocation decision A5, was located in month 8 in the Figure 1 strategy. For the alternative strategy, A5 has been moved to month 11. Similarly, the two month block labeled A2 in the Figure 1 strategy has been moved to month 8 in the alternative strategy. With a fixed return distribution for stocks and bonds, the Figure 1 strategy and the alternative investment panel strategies would have the same twelve month cumulative distribution, however if the return distribution is not fixed, the timing of the allocation blocks will affect the cumulative wealth distribution. We use the term "shuffling" to describe how we reorder the buy-and-hold blocks to different time periods, while simultaneously preserving their length. It is important to note that we are not shuffling returns. In each month, the stock and bond returns used to calculate the twelve-month cumulative returns are the same for each investment strategy. What changes across strategies is the allocation to stocks and bonds in a particular month.

Figure 4 shows how the accumulated wealth for the initial and alternative investment strategy differ over the twelve month horizon.

FIGURE 4
MONTHLY WEALTH ACCUMULATION OF INITIAL INVESTMENT STRATEGY AND ON POSSIBLE ALTERNATIVE ALLOCATION PRESERVING THE INVESTMENT STRATEGY



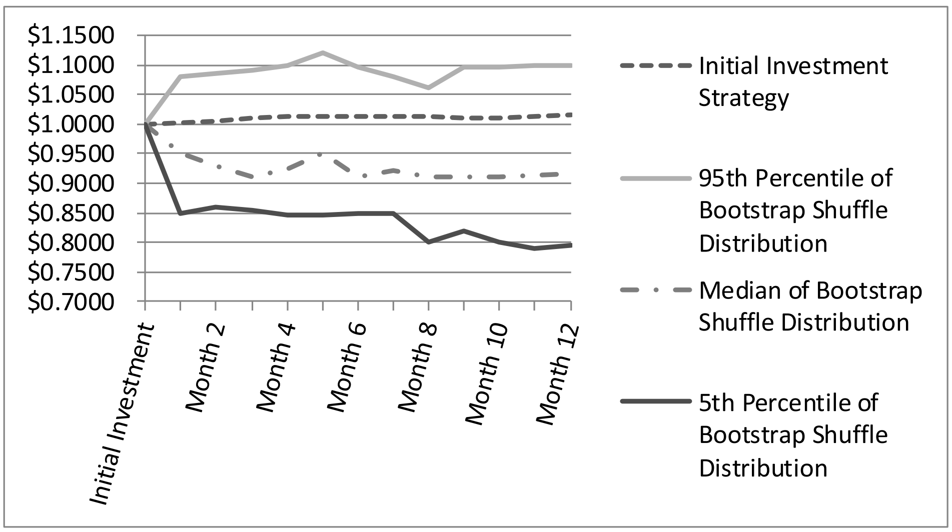
The figure shows two possible ex-post wealth accumulation paths derived from the ex-post stock and bond return series. Both investment alternatives consist of six buy-and-hold blocks with identical initial allocation proportions and investment lengths. The investment strategies differ only in the timing of rebalancing decisions. See Figure 3 for details on the initial allocations and block lengths.

Because the allocation effects of the alternative investment strategy are identical to the initial investment strategy shown in Figure 1, the difference in accumulated wealth between the initial investment strategy and the alternative strategy must be due solely to the timing effect and not an allocation effect. This isolating consequence is the basis of the bootstrap shuffling approach.

This approach is different from the bootstrapping procedure used by Brock, Lakonishok and LeBaron (1992) that generates a return series based upon an underlying return process such as a random walk, AR(1), or GARCH. Bootstrapping procedures generally do not assure that investors are in or out of the market for the same number of periods, and the bootstrapping procedures do not preserve the length of the allocation blocks. Because of this, standard bootstrapping procedures blur the distinction between allocation and timing effects and may falsely attribute excess returns to superior timing ability.

The particular randomization of the allocation block shown in Figure 4 is just one of many. The bootstrap shuffle repeats this randomization a large number of times and records the distribution of wealth across the various simulations.[2] Figure 5 gives a hypothetical result of the shuffling process. To construct the 5th and 95th percentile bands, the buy-and-hold allocation blocks are randomly shuffled and accumulated wealth is calculated for each random shuffle. This process is repeated to generate a distribution of accumulated wealth values associated with alternative rebalancing (timing) decisions. Note that by construction, all of the alternate investment strategies have the same allocation decisions (i.e., all have the same number of allocation blocks of the same lengths), so any differences in wealth are a result of when the rebalancing occurred.

FIGURE 5
ACCUMULATED WEALTH OF INITIAL INVESTMENT STRATEGY VERSUS BOOTSTRAP SHUFFLE DISTRIBUTION OF ACCUMULATED WEALTH



The bootstrap shuffle distribution of accumulated wealth was calculated by randomly shuffling the buy-and-hold allocation blocks shown in Figure 1. The accumulated wealth associated with each random shuffle is calculated using the monthly returns for the stock and bond indices shown in Figure 1. This process is repeated 1,000 times to generate the bootstrap shuffle distribution.

The accumulated wealth value associated with the initial investment strategy from Figure 1 falls above the mean of the bootstrap distribution, but below the 95th percentile of the distribution. We interpret this to mean that, holding the allocation decisions constant, the profits from the particular rebalancing decisions made in the initial investment strategy are not statistically different from the profits associated with a random assignment of the rebalancing decisions. Consequently the rebalancing decisions in the initial investment strategy were not value adding and resulted in unnecessary transactions costs.

To summarize, we can decompose the ex-post profits/returns from any investment strategy by breaking the profit/return sequence into allocation buy-and-hold blocks and rebalancing decisions. We generate an empirical distribution by shuffling the allocation decisions many times in such a way as to preserve the allocation decisions and holding period lengths. The 5th and 95th percentile bounds for this distribution give the confidence interval for the null that the initial investment strategy's rebalancing decisions are superior to random rebalancing. The mean of this distribution gives the amount of the initial investment strategy's accumulated wealth that derives from allocation. The difference between the initial investment strategy's accumulated wealth and the mean of the distribution is attributed to rebalancing (timing).

The bootstrap shuffle technique has broad applicability to many tests of market efficiency, including technical trading rules based on past price or volume patterns and trading rules based on public information signals such as phases of the business cycle, the weak dollar/strong dollar cycle, or disclosures of officer and director trading activity. If a market efficiency test can be characterized by a change in portfolio composition based upon a signal, our method can be used to separate the ex-post return into allocation and rebalancing components.

AN EMPIRICAL APPLICATION OF THE BOOTSTRAP SHUFFLE TECHNIQUE

We illustrate our technique using a trading rule based on the monetary policy environment. Research by Johnson and Jensen (1998) and Conover, Jensen, Johnson and Mercer (2005) finds that periods of decreasing discount rates (an expansive monetary policy) are associated with higher stock market returns and lower variability of returns. This finding implies that investors should be able to earn superior returns by using monetary policy signals to time stock market purchases. Specifically, when monetary policy shifts from restrictive to expansionary, investors should shift from bonds into stocks, and conversely should shift from stocks into bonds when monetary policy shifts from expansionary to restrictive. We use our bootstrap shuffle technique to determine whether profits from this trading rule are attributable to timing or asset allocation.

For our trading strategy we use the value weighted CRSP index cum-dividends as a proxy for a stock portfolio that mimics the market portfolio. We use the CRSP 30-year bond return for our bond portfolio. The data are monthly and run from October of 1957 to December of 2009.

The timing strategy we examine is based on whether the monetary environment is expansive or restrictive as defined by Johnson and Jensen (1998) and Conover, Jensen, Johnson and Mercer (2005). In their definition, an expansionary period begins when the Federal Reserve Bank (Fed) lowers the discount rate and continues until the Fed raises the discount rate, at which point a restrictive period begins. The restrictive period lasts until the Fed again lowers the discount rate. If we code a restrictive monetary regime as 1 and an expansive regime as 0, we have a trading signal just as described in our original example.

In the first monetary timing strategy, the investor starts with $1. At the beginning of each month he observes whether the monetary environment is expansive or restrictive. He then invests the dollar and any subsequent accumulated wealth in a stock portfolio if the monetary environment is expansionary and in a bond portfolio if the monetary environment is restrictive. In each subsequent month he switches his entire wealth between the stock and bond portfolio depending on the monetary environment. Figures 6 and 7 show the accumulated wealth from such a strategy and its resulting bootstrap attribution to timing and allocation.

FIGURE 6
MONETARY REGIMES AND ASSET RECOMMENDATIONS

Monetary Regime				
Start	**End**	**# of Months**	**Type of Regime**	**Portfolio Recommendation**
1957:10	1957:11	2	Expansive	Stock
1957:12	1958:08	9	Restrictive	Bond
1958:09	1960:06	22	Expansive	Stock
1960:07	1963:07	37	Restrictive	Bond
1963:08	1967:04	45	Expansive	Stock
1967:05	1967:11	7	Restrictive	Bond
1967:12	1968:08	9	Expansive	Stock
1968:09	1968:12	4	Restrictive	Bond
1969:01	1970:11	23	Expansive	Stock
1970:12	1971:07	8	Restrictive	Bond
1971:08	1971:11	4	Expansive	Stock
1971:12	1973:01	14	Restrictive	Stock
1973:02	1974:12	23	Expansive	Bond
1975:01	1977:08	32	Restrictive	Stock
1977:09	1980:05	33	Expansive	Bond
1980:06	1980:09	4	Restrictive	Stock
1980:10	1981:11	14	Expansive	Bond
1981:12	1984:04	29	Restrictive	Stock
1984:05	1984:11	7	Expansive	Bond
1984:12	1987:09	34	Restrictive	Stock
1987:10	1990:12	39	Expansive	Bond
1991:01	1994:05	41	Restrictive	Stock
1994:06	1996:01	20	Expansive	Bond
1996:02	1999:08	43	Restrictive	Stock
1999:09	2000:12	16	Expansive	Bond
2001:01	2004:06	42	Restrictive	Stock
2004:07	2007:08	38	Expansive	Bond
2007:09	2009:12	28	Restrictive	Stock

The table entries define whether the monetary regime is expansive or restrictive and the number of months for each regime. The corresponding asset recommendation is also given. Columns 3 and 5 give the 28 allocation blocks that define the monetary regime strategy for the 627 month period from 1957:10 to 2009:12. These 28 blocks determine the return (wealth accumulation) for the strategies and are what is shuffled in the bootstrap simulations.

FIGURE 7
ATTRIBUTING WEALTH ACCUMULATION TO TIMING OR ALLOCATION

Holding Period	Number of Months	Accumulated Wealth from Trading Strategy	Accumulated Wealth from a Buy-and-Hold Stock Only Strategy	5th Percentile Bootstrap	95th Percentile Bootstrap	Mean Bootstrap (Allocation Effect)	Timing Effect
1957:10 - 1962:09	60	$1.32	$1.65	$1.02	$1.58	$1.31	$ 0.01
1957:10 - 1969:09	120	$2.04	$3.45	$1.60	$2.57	$2.05	$ (0.01)
1957:10 - 1972:09	180	$3.49	$4.54	$1.67	$3.80	$2.67	$ 0.82
1962:10 - 1967:09	60	$1.54	$2.09	$1.40	$1.70	$1.52	$ 0.02
1962:10 - 1972:09	120	$2.64	$2.75	$1.47	$2.70	$2.10	$ 0.54
1962:10 - 1977:09	180	$5.29	$2.88	$1.54	$4.83	$2.94	$ 2.34
1967:10 - 1972:09	60	$1.76	$1.35	$0.94	$1.84	$1.38	$ 0.38
1967:10 - 1977:09	120	$3.53	$1.41	$1.30	$3.33	$2.11	$ 1.41
1967:10 - 1982:09	180	$6.02	$2.49	$1.63	$4.89	$2.96	$ 3.06
1972:10 - 1977:09	60	$1.99	$1.04	$1.24	$2.08	$1.78	$ 0.21
1972:10 - 1982:09	120	$3.39	$1.81	$1.27	$3.23	$2.22	$ 1.17
1972:10 - 1987:09	180	$10.43	$5.72	$2.60	$7.44	$4.77	$ 5.65
1977:10 - 1982:09	60	$1.70	$1.84	$1.39	$2.07	$1.74	$ (0.04)
1977:10 - 1987:09	120	$5.22	$5.58	$3.00	$5.56	$4.28	$ 0.94
1977:10 - 1992:09	180	$8.91	$8.28	$3.76	$6.97	$5.23	$ 3.68
1982:10 - 1987:09	60	$2.75	$2.71	$2.22	$2.75	$2.40	$ 0.34
1982:10 - 1992:09	120	$4.69	$4.03	$2.30	$3.81	$2.95	$ 1.74
1982:10 - 1997:09	180	$9.04	$10.11	$4.34	$8.61	$6.15	$ 2.88
1987:10 - 1992:09	60	$1.70	$1.92	$1.64	$1.70	$1.67	$ 0.02
1987:10 - 1997:09	120	$3.27	$4.81	$2.08	$3.81	$3.00	$ 0.27
1987:10 - 2002:09	180	$3.03	$4.31	$1.83	$5.99	$3.49	$ (0.46)
1992:10 - 1997:09	60	$1.91	$2.48	$1.78	$2.25	$1.98	$ (0.07)
1992:10 - 2002:09	120	$1.77	$2.22	$1.29	$3.62	$2.21	$ (0.44)
1992:10 - 2007:09	180	$3.09	$4.98	$2.15	$4.78	$3.03	$ 0.06
1997:10 - 2002:09	60	$0.96	$0.93	$0.74	$1.40	$1.06	$ (0.10)
1997:10 - 2007:09	120	$1.68	$2.08	$1.14	$2.04	$1.40	$ 0.28
1997:10 - 2009:09	147	$1.25	$1.64	$0.89	$3.17	$1.59	$ (0.34)

The table gives the accumulated wealth from following the monetary timing rule and a stock only buy-and-hold strategy. In addition, the 5th and 95th percentiles for accumulated wealth are given for a bootstrap simulation that preserves the allocation of the timing strategy. If the timing strategy accumulated wealth falls within the 5th to 95th bounds, the timing strategy is not statistically different from a random strategy with the same allocation blocks. Statistically significant timing results are shaded. The mean of the bootstrap distribution gives the expected wealth accumulation for the strategy allocation blocks. The difference between the actual strategy accumulated wealth and the average is the dollar return attributed to timing. Accumulated wealth for various sub-periods is shown for holding periods of 60, 120 and 180 months.

Figure 6 shows 627 months of the "signal" for the monetary regime timing strategy. The Fed alters its posture between restrictive and expansive over this 52-year period in durations from 2 to 45 months as shown. For example, with a 10 year (120-month) horizon beginning in 1957:10, the trading strategy would have recommended an initial allocation of $1 into the stock portfolio. The funds would remain there for two months at which time the Fed would have altered its posture from expansive to restrictive and the investor would rebalance his initial $1 investment and proceeds to the bond portfolio. The funds would remain in the bond portfolio for 9 months and then get rebalanced back into stocks. The process would continue until 1967:09. Figure 7 gives the accumulated wealth for the trading positions in Figure 6. Accumulated wealth is calculated for holding periods of 5 years (60 months), 10 years (120 months) and 15 years (180 months) for various data sub-periods. As seen in row 2 of Figure 7, from 1957:10 to 1969:09 the strategy of rebalancing wealth between a stock portfolio in expansive monetary regimes and a bond portfolio in restrictive regimes would have accumulated $2.04 for every dollar invested. Randomly shuffling the six trading blocks associated with the 120 month horizon in Table 7 results in 5th and 95th percentile values of $1.60 and $2.57 respectively. Because the realized wealth accumulation of $2.04 lies within these bounds, we can conclude that with this horizon and over this time period, the monetary regime timing strategy is not statistically different from a random timing strategy with the same allocation blocks. The mean bootstrap value indicates that the allocation blocks given by the 120 month monetary regime timing strategy would be expected to earn $2.05, which is close to the $2.04 actually earned. This implies that the realized strategy's earnings are substantially due to allocation and not timing. Finally, we see that a simple buy-and-hold stock investment would have earned $3.45 over the same investment horizon.

Statistically significant timing results are shown by the shaded cells in Figure 7. The monetary regime timing strategy generally fares better for longer investment horizons and also for time periods beginning in the late 1960's to the mid 1980's. For example, following the trading strategy of rebalancing wealth between a stock portfolio in expansive monetary regimes and a bond portfolio in restrictive regimes for the 180-month holding period beginning 1982:10 and ending 1997:09 would have accumulated $9.04 for every dollar invested. This is well outside the 5th and 95th percentile bounds of $4.35 and $8.61 calculated by applying the block shuffling procedure. The expected wealth accumulation from the bootstrapped block shuffling strategy is $6.15. As a result, for this period and investment horizon, the timing implied by the monetary regime adds an additional $2.88 to the wealth accumulation for every dollar invested.

The trading strategy has been less successful for the most recent sub-periods beginning in the late 1980's and thereafter as the accumulated wealth from the trading strategy in these periods is generally well below the mean of the bootstrapped distributions.

For comparative purposes, the accumulated wealth from a stock-only buy-and-hold strategy is also shown in Figure 7. This comparison highlights the dangers of confounding the effects of allocation and timing decisions on returns. To see this, consider the 60-month holding period from 1972:10 to 1977:09. The accumulated wealth from the trading strategy for this period was $1.99 per $1.00 invested. This is substantially higher than the $1.04 accumulated wealth from a buy-and-hold investment in the stock index. However, the $1.99 in accumulated wealth from the trading strategy is below the 95th percentile of the bootstrap shuffle distribution of $2.08 and is only slightly above the mean of the bootstrap shuffle distribution of $1.78. In this case, the superior performance of the trading strategy was due to allocation, not timing effects, yet a comparison to the buy-and-hold result would have falsely presumed that the trading rule was a successful strategy for timing investments.

INCORPORATING TRANSACTIONS COSTS

Figure 7 shows that a monetary regime timing strategy generated statistically significant timing returns in several sub-periods of the data set. However, the rebalancing from stocks to bonds was done disregarding transactions costs which would certainly be present. In addition, the presence of transactions costs biases the choice of investment strategy toward buy-and-hold since buy-and-hold incurs only the initial investing and liquidation fees. Figure 8 repeats the investment strategy shown in Figure 7, but each time the portfolio switches from stocks to bonds or from bonds to stocks, the accumulated wealth is reduced by 2 percent as a transactions fee. The transaction fee is also incorporated into the bootstrapping 5th and 95th percentiles and the bootstrap mean to make a fair comparison. While the dollar amounts in Figure 8 are necessarily lower than those in Figure 7, we see that the pattern of statistically significant timing returns is persistent even with a 2 percent transactions cost for 6 of the 8 sub-periods identified in Table 7.

FIGURE 8
ATTRIBUTION WEALTH ACCUMULATION TO TIMING OF ALLOCATION 2 PERCENT REBALANCING COSTS

Holding Period	Number of Months	Accumulated Wealth from Trading Strategy	Accumulated Wealth from a Buy-and-Hold Stock Only Strategy	5th Percentile Bootstrap	95th Percentile Bootstrap	Mean Bootstrap (Allocation Effect)	Timing Effect
1962:10 - 1977:09	180	$4.23	$2.88	$1.39	$4.05	$2.56	$ 1.68
1967:10 - 1977:09	120	$2.94	$1.41	$1.18	$3.01	$1.87	$ 1.07
1967:10 - 1982:09	180	$4.63	$2.49	$1.37	$4.20	$2.55	$ 2.08
1972:10 - 1982:09	120	$2.94	$1.81	$1.19	$2.94	$2.03	$ 0.91
1972:10 - 1987:09	180	$8.69	$5.72	$2.30	$6.85	$4.29	$ 4.40
1977:10 - 1992:09	180	$7.58	$8.28	$3.33	$6.35	$4.73	$ 2.85
1982:10 - 1992:09	120	$4.24	$4.03	$2.12	$3.59	$2.75	$ 1.49
1982:10 - 1997:09	180	$7.84	$10.11	$3.88	$8.10	$5.64	$ 2.21

The table shows the effect of a 2 percent rebalancing cost for the trades in Figure 7 that were statistically significant assuming zero transactions costs. The table figures show the accumulated wealth starting from a $1 investment at the beginning date and following a rebalancing strategy based on the monetary regime, either expansive or restrictive. In a given month if the monetary regime is expansive, the portfolio is invested in the CRSP value-weighted portfolio. If the monetary regime is restrictive, the portfolio is invested in a 30-year Treasury bond portfolio. The entire accumulated wealth is switched from the stock to bond portfolio with each change in monetary regime. For comparison, the 5th and 95th percentiles give the accumulated values of rebalancing in a random fashion that exactly mimics the percentage of time the funds are in the stock and bond portfolios given by the strategy, but "shuffles" the timing. In this way allocation decisions are preserved and the only difference is timing. Shaded cells indicate a statistically significant timing strategy. Six of the eight significant trading periods remain significant even with a 2 percent rebalancing cost.

CONCLUSION

Standard tests of trading strategies designed to exploit market inefficiencies typically compare the profits from implementation of the trading strategy to profits from a buy and hold strategy or a reference strategy calculated using bootstrapping techniques. Higher profits for the trading strategy are attributed to timing, but may in fact be caused by asset allocation differences between the trading strategy and the reference strategy. We propose a modification of the bootstrapping simulation technique that allows a decomposition of trading profit into allocation and timing components. This approach holds constant the allocation decision by ensuring that the reference strategy incorporates the same allocation decisions as the timing strategy (both in terms of the total length of time in the market and the length of each allocation block). The decomposition technique is illustrated using a monetary policy timing strategy, however, the approach can be applied to a wide variety of trading strategies based on technical trading rules or trading rules designed to exploit semi-strong form market inefficiencies. Use of this technique allows a more accurate measurement of the true profit to these trading strategies, and allows portfolio managers to determine whether efforts expended on rebalancing (timing) activities are justified by higher portfolio returns.

ENDNOTES

1. Our use of the term "timing" indicates a rebalancing event triggered by some observed signal.
2. In the actual applications of our technique, we repeat the bootstrapping 1,000 times.

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