The Journal of Portfolio Management

VOLUME 25 NUMBER 1 FALL 1998

Beating the Bond Market with No Skill

How an "altered index" can outperform an established index.

Roland W. Lochoff

A PUBLICATION OF INSTITUTIONAL INVESTOR, INC.

Beating the Bond Market with No Skill

How an "altered index" can outperform an established index.

Roland W. Lochoff

Fixed-income portfolio managers are measured against well-established bond indexes. This makes sense. If the indexes are fair comparisons, it should be impossible to construct a portfolio that beats the index by adhering to a single rule.

Given how few managers systematically beat the index, the index does appear to be fair. Nevertheless, if most managers are abiding by the index's basic structure, it is possible that they are simply handicapping themselves in the same way that the index is handicapped.

This article first explores the rationales behind bond index construction. It then describes a way indexes could be constructed so that over history an "altered index" would outperform an established index.

TINKERING WITH BOND INDEXES

The Lehman Brothers Aggregate Bond index, as an example, is made up of a broad range of investment-grade bonds across many sectors and subsectors. The bonds are weighted in the index in proportion to their capitalization.

At periodic intervals, indexes are rebalanced to realistically represent the events that take place in a real portfolio, like reinvesting coupons and maturing bonds, albeit without transaction costs. If rebalancing methodologies are inadequate, it would be feasible to "outsmart" the rebalancing regimen. Arbitrage has insured that rebalancing regimens are in fact realistic.

It is also possible to argue that normative bond

ROLAND W. LOCHOFF is senior manager, fixed income investments, at PanAgora Asset Management in Boston (MA 02110).

portfolios should encompass qualities and sectors that are not in the index, but there are indexes that represent these classes that can be combined in order to create an appropriate reference for a portfolio in terms of asset coverage.

The final possibility is that the way bonds are combined in the index is suboptimal. How should bonds be combined in an index?

CAPITALIZATION WEIGHTS AND EFFICIENCY

Equity indexes most commonly used by institutional investors are capitalization-weighted. The underlying economics support this weighting scheme. The basic idea is that efficient markets funnel capital to the most effective users of the capital in the investable universe. The net result of these flows is index weights that are proportional to capitalization.[1]

When bond indexes were first designed, since equity indexes used by the majority of institutional investors were capitalization-weighted (with good economic justification), it made sense to construct the bond indexes as capitalization-weighted. Over the last twenty-five years, fixed-income indexes constructed as capitalization-weighted combinations of large universes of bonds have become the reference norm. As the normative reference, large sums of money are concentrated around the framework of the indexes.

But is a capitalization-weighted scheme sensible for bond indexes? We certainly cannot make claims about the indexes representing an efficient claim on debt capital. If a firm (or sovereign state) issues lots of debt, it is difficult to interpret whether that is detrimental or beneficial to the firm's economic well-being. Some may say that a large amount of debt is a bad sign. On the other hand, though, debt issuance may result from efficient choices among the supply of and demand for capital in the debt and equity markets, or preferences for present versus future consumption.[2]

In fact, there is considerable empirical evidence that choices made for issuing and buying debt are economically inefficient. For example, the well-known Ibbotson and Sinquefield [1997] data show that intermediate bonds have outperformed much riskier long bonds. As another example, the upward-sloping yield curve implies that there are higher yields available for very little incremental interest rate risk. Ilmanen [1996] shows that over any reasonable horizon, portfolios of one-year maturity outperform one-month bonds by an amount far in excess of the incremental risk.

We can surmise why this is so. The polite way is to refer to clienteles, such as entities that are significant buyers, being subject to tax profiles that do not have a natural counterweight. The impolite way suggests that there are significant rigidities built into the system that allow bad habits to persist for long periods of time. If the market were to become more transparent, and economic equilibrium forces be less impeded, prices would reflect more of a collective supply/demand equilibrium than they now do.

A REVEALED PREFERENCE INDEX

If capitalization-weighted indexes are inefficient, what indexes are efficient? A natural approach to this question is to investigate where natural clienteles are and where capital does flow. That is, we will construct an index that uses prices from the market to steer toward an index that offers the best combination of risk and return. If bonds are bought to match the characteristics of this index, the happy outcome is that the index will outperform typical institutional indexes *with no active management*.

Active management is traditionally defined as taking positions in the bond market away from the index that vary over time as a function of forecasts. More recently, institutional investors have defined a spectrum ranging from pure passive indexing, through enhanced indexing, through active management, ultimately through to speculation, as a function of the level of residual risk relative to industry benchmarks.

Residual risk is measured as the standard deviation of the strategy's returns relative to the benchmark. It is also known as tracking error. For bond strategies, tracking errors on the order of 10 basis points a year or lower are considered passive. Up to 50 bp can be classified as enhanced indexing. Between 50 and 200 basis points is a range for typical institutional strategies.

We propose a "revealed preference" index that is passive according to the first definition in that time-varying forecasts are not a component, yet is active in that it will have tracking error relative to the standard index. The overall risk of the revealed preference index will be comparable to a standard index.

CALCULATING A REVEALED PREFERENCE INDEX

Calculating the ratio of return to each unit of risk is a starting point. The Sharpe ratio is defined as the return of a portfolio in excess of the risk-free rate divided by the portfolio's standard deviation.

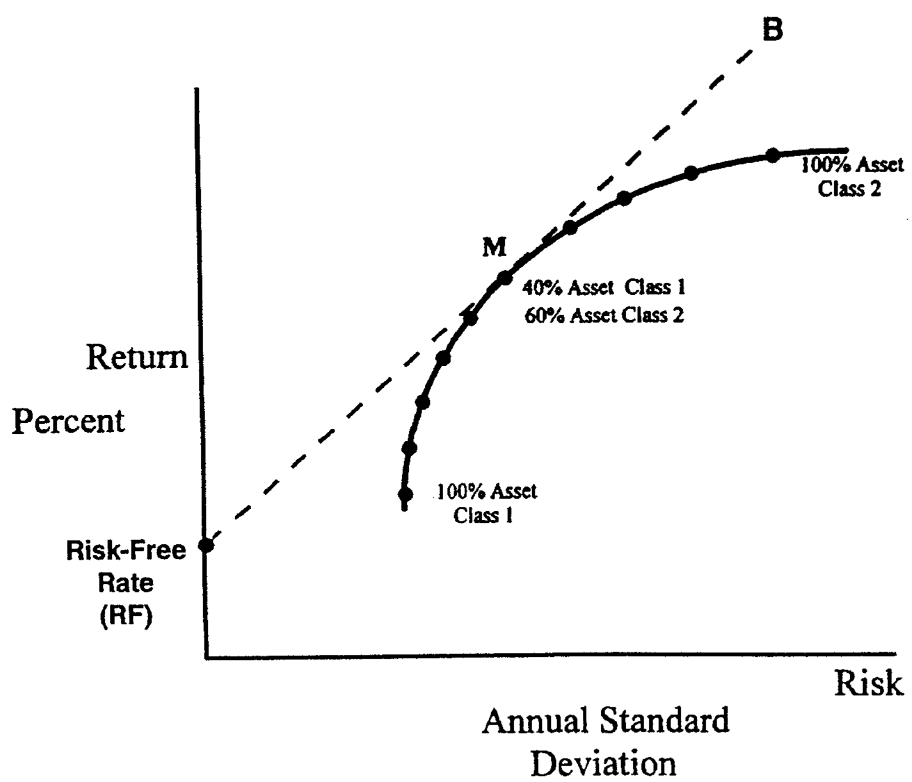
The higher the Sharpe ratio, the higher the excess return available per unit of risk. As long as return per unit of risk is rising, we are better off. If the best Sharpe ratio is available only at levels of risk that are too high or too low, we can adjust to the desired risk habitat by either borrowing or lending at the risk-free rate to be in the exact risk habitat of preference.

In Exhibit 1, the point M represents the highest Sharpe ratio of an efficient frontier. Prior to M on the efficient frontier, the Sharpe ratio will decrease. After M, the Sharpe ratio also declines. The straight line RF-B represents different combinations of the optimal portfolio M and the risk-free rate, allowing investors to choose the level of risk appropriate to their level of risk tolerance, all with the same (and highest) Sharpe ratio.

This is not new. While the concept of an efficient frontier is completely taken for granted, more than forty years after the original ideas were described, we seem to continue to ignore the idea that only one point on the efficient frontier is an optimal portfolio. Perhaps this is why modern portfolio theory still bears the adjective "modern." Today, most institutional portfolios are configured so that the asset classes chosen determine the risk habitat of the fund, rather than independently choosing asset classes and only then choosing a desired risk habitat.

Once the idea that a portfolio's risk habitat can be mobile takes root, many insights become clear. One is that it allows direct comparison of the financial efficiency of two indexes. A second insight would be to use the framework to create an optimally efficient index and then compare it to the standard capitalization-weighted index. We can provide an exercise that illustrates the latter concept.

EXHIBIT 1
HIGHEST SHARPE RATIO



The Ibbotson and Sinquefield data say that intermediate bonds have outperformed long bonds. For the entire period of monthly data dated from January 1926 through September 1997, the mean annualized return to intermediate bond is 5.23% per year versus 5.14% for long bonds. Excess returns over the risk-free rate are, respectively, 1.42% and 1.36% per year. Moreover, the risk of intermediate bonds is 4.25% per year versus 7.65% for long bonds. These data yield a Sharpe ratio for intermediate bonds that is twice the magnitude of the long bond Sharpe ratio (0.34 versus 0.17). This result applies similarly over almost any horizon of the Ibbotson and Sinquefield data.

Exhibit 2 shows returns, risks and Sharpe ratios calculated in ten-year blocks starting with the latest data as of the time of writing.

EXHIBIT 2
INTERMEDIATE VERSUS LONG BONDS

		Excess Return	Risk	Sharpe Ratio
Whole Period	Intermediate	1.42%	4.25%	0.34
	Long	1.36%	7.65%	0.17
10/87-9/97	Intermediate	2.95%	4.41%	0.67
	Long	5.71%	8.53%	0.67
10/77-9/87	Intermediate	0.90%	7.80%	0.12
	Long	-0.72%	14.04%	-0.05
10/67-9/77	Intermediate	0.83%	4.74%	0.18
	Long	-0.73%	8.58%	-0.08
10/57-9/67	Intermediate	0.47%	3.27%	0.14
	Long	-0.76%	5.00%	-0.15
10/47-9/57	Intermediate	-0.27%	1.94%	-0.14
	Long	-0.97%	3.65%	-0.26
10/37-9/47	Intermediate	2.40%	2.07%	1.16
	Long	3.84%	3.54%	1.08
10/27-9/37	Intermediate	0.28%	2.89%	0.10
	Long	2.65%	4.93%	0.54

Ibbotson and Sinquefield [1997] data: Jan 1926 - Sept 1997.

Intermediate bonds have a superior Sharpe ratio to long bonds in every decade except for the decade including the 1929 crash, which is arguably an anomalous decade. This history suggests that long bonds are less efficient than intermediate bonds. Since long bonds are part of the capitalization-weighted index, such a result implies that "better" indexes can be constructed.

For example, we can create a synthetic long bond index with a Sharpe ratio of 0.34, but with an annual standard deviation of 7.65% by combining the intermediate bond index with a short position in the risk-free asset. The return of the "reconstructed long bond index" would be 6.33% per year in contrast to the actual 5.14%. Over the seventy-plus years in the sample, the compounded difference means that a $100 investment would total $8,176 versus $3,646 *for the same level of realized risk.*

A BETTER REVEALED PREFERENCE INDEX

The ideas described using intermediate and long bonds can be extended by analyzing the Sharpe ratios of more than two maturities. Furthermore, any practical implementation of these ideas should recognize potential instabilities in risk measures. See Chopra and Ziemba [1993]. I describe a strategy developed using these principles.

The data used for empirical testing are a set of bellwether returns published by Lehman Brothers that give time series of total return for nine different maturities going back to January 1981. These returns are fed into an optimizer whose basic goal is to trade off active risk against return. In this case, forecast return is defined simply as the average geometric monthly returns for each maturity from January 1981 until the period immediately prior to the optimization in question. Risk is also simply defined as the historical risk from the same data.

Using these data, the empirical result shows that the shortest maturities have the highest Sharpe ratios, and the ratio declines monotonically with increasing maturity. We can only surmise why this empirical result holds so steadily through time, but it is rooted in the ideas economists have had over the last century for explaining the term structure of interest rates.

Certainly the evidence that the average term structure is upward-sloping suggests that there is a risk premium for lending long. In addition, the need to hold short-maturity balances for upcoming transactions that might occur, and for insurance against uncertainties in future income, prices, and needs, implies that short maturities are held for reasons other than pure investment needs. Basically, there are a host of different supply/demand effects other than pure financial return that determine the shape of the term structure.

Whatever the reason for the pattern of Sharpe ratios, given these relationships, an optimizer fed to create the highest Sharpe ratio portfolio with risk akin to that of the Lehman Aggregate results in a position in the shortest maturity with its modest risk leveraged to that of the index. This would look like a very large

EXHIBIT 3
SIMULATED PERFORMANCE

	Annual Averages				
	Excess Return	Risk	Duration	Beta	Sharpe Ratio
Portfolio	3.43%	3.23%	4.36 years	1.01	1.06
Index	2.67%	3.73%	4.36 years	1.00	0.72
Active	0.76%	1.13%	0.00 years	0.01	0.67

short position in the risk-free asset and a very long position in three-month maturities. The notional amount invested at three months would exceed the value of the portfolio by an amount on the order of ten or more. This is potentially dangerous, since small measurement errors or anomalous periods could result in large tracking error relative to the index.

Therefore, we insure against risk by imposing further safety measures to keep bets more distributed. In particular we mandate that no more than 100% of portfolio value may be invested notionally in any single maturity. We target tracking error to be on the order of 1.5% per year and assume overall risk that matches the index. Finally, we target a weighted beta of one and duration targets. Beta in this case is defined as the relative volatility of a particular maturity's returns next to the index. A typical portfolio has investments distributed more uniformly across maturities, albeit with a pattern quite alien to the capitalization-weighted index used as the reference.

Investing this portfolio and rebalancing annually realizing the Lehman bellwether index returns produces the results in Exhibit 3. We use the first three years of data as the starting point for the optimizations, so results represent returns for the fourteen years starting in 1984.

The noteworthy numbers are active return of 0.76% per year with tracking error (active risk) of 1.13% per year. The Sharpe ratio of the strategy, by design, exceeds the index, 1.06 versus 0.72. The active Sharpe ratio, more commonly called the information ratio (see Grinold and Kahn [1995]), defined as active return divided by active risk is 0.67.

To get some perspective on these numbers, it is instructive to compare them to a universe of institutional fixed-income managers encompassing many active styles. Exhibit 4 from Kahn [1997] shows information ratios both before and after fees for this universe. There are managers who have done well while others have done poorly. To efficient market advocates it is not surprising that the median manager has an information ratio of 0.01 before fees.

Since active bond returns are modest, fees lower information ratios dramatically. It appears that the strategy described above falls into the seventieth percentile before fees. If we back out the fees implied by the table and the information ratio of the strategy, it implies that a fee of 43 basis points per year would place the strategy in the first quartile after fees relative to institutional peers.

Exhibit 5 shows the performance of the strategy year by year. If the portfolio had systematic biases, it would be visible in performance of this sample, which has seen rates rise and fall, yield curves invert, and a decent range of market environments. As an example, if the duration of the portfolio were systematically long, it would outperform in bull markets and underperform in bear markets. The bull market of 1991 and the bear market of 1994, which both show positive active value, indicate that this is not the case. 1985 shows a case where the strategy has negative value-added.

Attributing performance is not difficult. Since the strategy will overweight short maturities, when the yield curve flattens or inverts, short returns are adversely affected relative to long; performance should be poor. To stress-test for the strategy we use post-1948 bond data to explore a worst case scenario.

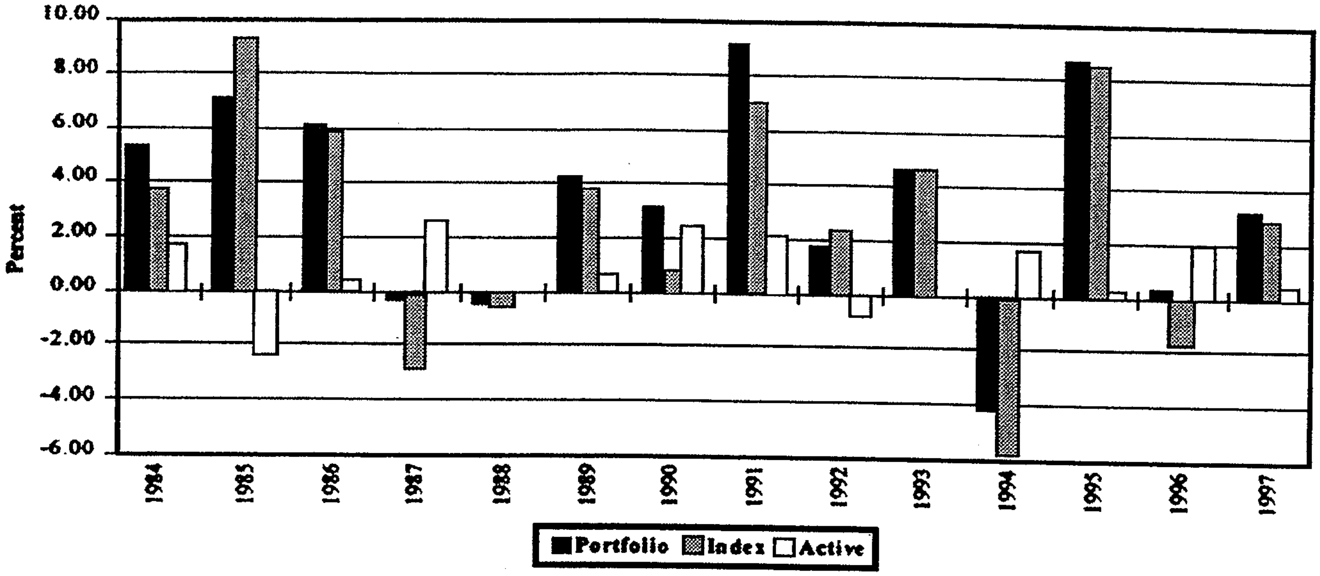
During the first oil shock between December 1972 and August 1973, short rates climbed by over 3.5% while long rates rose less than 0.5%. Calculations

EXHIBIT 4
INSTITUTIONAL FIXED-INCOME INFORMATION RATIO DISTRIBUTION

Percentile	Before Fees	After Fees
90	1.81	1.29
75	0.89	0.38
50	0.01	-0.57
25	-0.62	-1.37
10	-1.50	-2.41

Source: BARRA.

EXHIBIT 5
ANNUAL PERFORMANCE



show that a strategy of this nature would have underperformed by about 2.8%, which is gratifyingly within the norms of a two-standard deviation event relative to the planned tracking error of 1.5%.

Needless to say, interest rate evolutions of this nature occur less frequently than other evolutions, delivering overall favorable results.

TURNING PASSIVE INTO ACTIVE

This strategy depends on the idea of index inefficiency and is implemented with no implicit forecasts. It hence may be classified as passive, although with some fancy optimization techniques.

There are several ways to build active strategies on the foundation of these principles. As the note on worst case scenarios suggests, holding a steady proportion in short maturities will be suboptimal if flattening yield curves can be anticipated. Without giving away the store, there are a host of more subtle ways to add value.

In addition, the phenomenon described appears not to be confined to the U.S. At the very least, this suggests that similar strategies could be implemented in other countries. Perhaps, more interestingly, the relative Sharpe ratios of shorter maturities could be used as a gauge of value in country selection fixed-income strategies.

ENDNOTES

[1]Statisticians usually presume that the S&P 500 is the investable universe. Theoreticians clearly understand that there are stocks outside the S&P 500, stocks outside the U.S., other asset classes, and even good investment opportunities for which successful conduits for financing are not yet developed. The latter set is the true "market." The two groups usually agree not to talk about this discrepancy, although Roll and Ross [1994] have interesting insights into bridging the gap.

[2]Another approach within the framework of the capital asset pricing model, when all stocks and bonds are held in a "market" portfolio, is that corporate bonds delever the stock since the stocks are, in effect, short the bonds, and the net position is in unlevered stock. Sovereign debt is more of a problem since "we" issue it. But we hold the liabilities (future taxes) and the assets, which should (given some distributional leapfrog) net out.

REFERENCES

Chopra, V.K., and W.T. Ziemba. "The Effects of Errors in Means, Variances, and Covariances on Optimal Portfolio Choice." *Journal of Portfolio Management*, Winter 1993.

Grinold, R.C., and R.N. Kahn. *Active Portfolio Management*. Burr Ridge, IL: Richard D. Irwin, Inc., 1995.

Ibbotson, R.G., and R.A. Sinquefield. *Stocks, Bonds, Bills, and Inflation*. Charlottesville, VA: Financial Analysts Research Foundation, 1997.

Ilmanen, A. "Does Duration Extension Enhance Long-Term Expected Returns?" *Journal of Fixed Income*, September 1996.

Kahn, R.N. "Bond Managers Need to Take More Risk." Working paper, BARRA, Inc., 1997.

Roll, R., and S.A. Ross. "On the Cross-sectional Relation Betwee Expected Returns and Betas." *Journal of Finance*, March 1994.